PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

VOL. XXI. CHICAGO, MARCH 1, 1917 No. 5

Absorption Plant for Distilled Water Ice

NORTH PLANT OF POLAR ICE & FUEL CO., MADE NEW BY INSTALLATION OF 2 ICE MAKING MACHINES. EVAPORATORS FURNISH STEAM FOR POWER AND CONDENSATE FOR ICE. NOVEL TUBE CLEANING METHOD

IN INDIANAPOLIS the competition in the ice business is severe, and to meet the low price charged for this summer necessity has taxed the ingenuity of everybody in the industry. The Polar Ice & Fuel Co. operates 3 plants well scattered over the city to facilitate deliveries without excessive loss in transit. During the last season, what is known as the North Plant, located at 20th St. and Northwestern Ave., was forced into service before its new equipment could be properly insulated and other precautions taken to secure the highest economy, but the results obtained were above expectations and invite a study of the system and equipment by all interested in the ice industry, for the needs of the plant have been well worked out and the machinery so proportioned that very little of the heat contained in the steam leaving the boilers is allowed to go to waste.

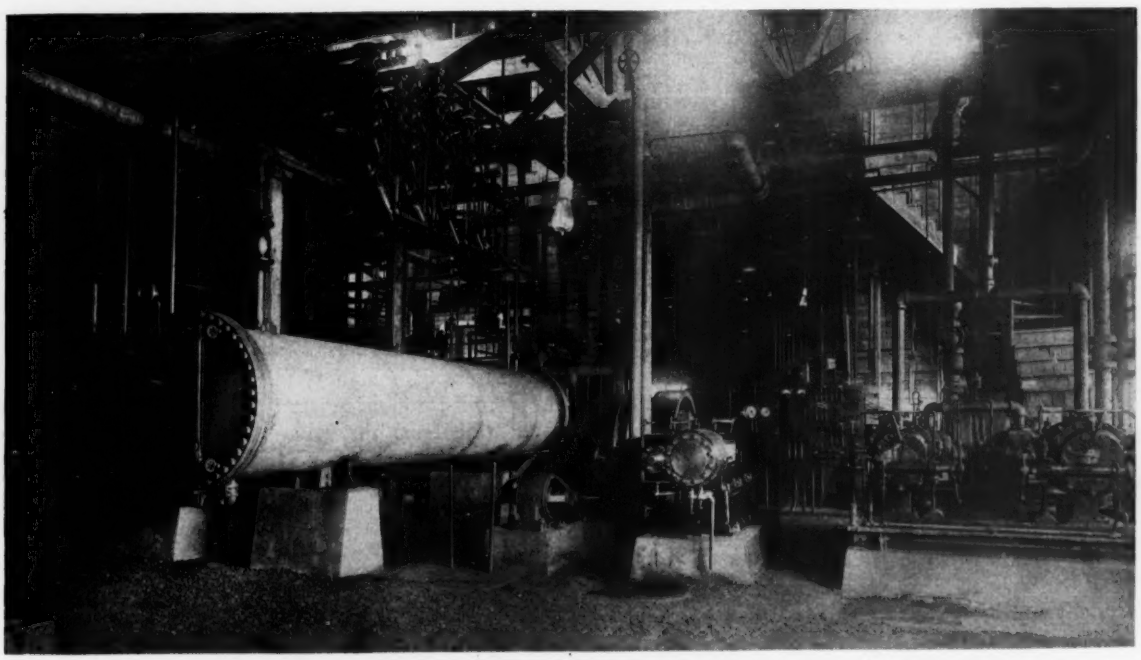


FIG. 3. AMMONIA GENERATORS WITH RECTIFIERS OVERHEAD, ELECTRIC GENERATOR AND AIR COMPRESSOR

OUTLINE OF PROCESS

THE ABSORPTION process of ice making is employed in this plant and is diagrammatically shown in Fig. 1. From the ammonia generator, which is heated by exhaust steam, the wet gas goes to the rectifier where the moisture is separated out and returned to the generator, the dry ammonia gas going to the condenser. Here it is changed to the liquid anhydrous form and passes through a receiver to the expansion or regulating valve where the pressure is reduced and it enters the brine cooler. The ammonia gas generated here due to the

reduced pressure and evaporation falls to a low temperature, cools the brine and is drawn through fore cooler coils to the absorber by the strong attraction of the weak liquor which has been drawn from the bottom of the generator through the exchanger and the weak liquor cooler to meet the gas in the absorber. Here the strong liquor is formed which is cooled further before going to the aqua receiver on its way to the pump which forces it back to the generator by way of the exchanger where the hot weak liquor is partially cooled on its way to the absorber.

Cooling water used in this plant is drawn from wells. It passes first through the condenser, then through the absorber, after which it divides, part going to the weak liquor cooler and the flat cooler, the other part going to the rectifier. The water used to feed the boilers is drawn from the waste from the rectifier and after treatment in a water softener passes on its way through a double-pipe heater where its temperature is raised by the returns from the reboiler and condensate from the generator and the evaporator.

ice to be made. In this plant, the deficiency is made up by a multiple evaporation system consisting, first, of 3 Houston, Stanwood & Gamble return tubular boilers, each of 150 hp. capacity, in steel incased settings, served by dutch oven furnaces provided with Kelly shaking grates and working at a pressure of 110 lb. Steam generated here is used to operate the boiler feed pumps, of which there are two, and to boil the water in the evaporators. The exhaust from the boiler feed pumps goes to the ammonia generators, while the condensate from the evaporator is discharged to the reboiler through a section of the heater.

The evaporators, two in number, are each rated at 50 tons capacity; each shell is 30 in. diameter by 15 ft. long and contains 36 2-in. steam pipes extending the length of the shell. These generate steam at 80 lb. and furnish the supply necessary for operating pumps, electric generator and air compressor, and heating the reboiler. An interesting comparison is that of the heating surface of an evaporator to that of the boiler that furnishes the steam. The advantage in favor of the

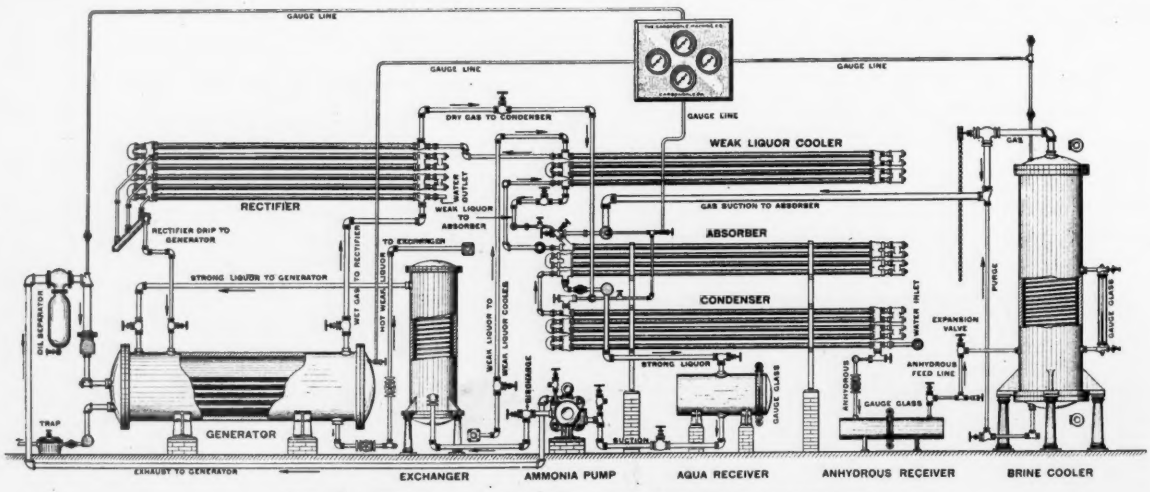


FIG. 1. DIAGRAM OF DOUBLE PIPE ABSORPTION MACHINE

Steam generated in the boilers is used to boil water in the evaporators which supply steam at lower pressure for operating the principal machinery of the plant. All exhaust steam goes to the ammonia generator, where it condenses and the condensate is then delivered through a section of the heater to the reboilers, as is also the condensate formed in the evaporators.

Only one combination reboiler and skimmer is installed, but its rated capacity is 100 tons a day. It is located on the roof, the condensate from the various sources being delivered to it by pump and receiver. Heating is done by steam from the evaporators at 80 lb. pressure, the condensate forming in the heating coil being delivered by a trap to the water compartment of the reboiler.

From the reboiler the purified water passes through a section of the feed-water heater, the flat cooler, fore cooler and filters to the ice cans.

Steam Supply

In the absorption system, the only mechanical part is the ammonia pump. For this reason sufficient condensate is not furnished to supply water enough for the evaporator is due to the utilization of the latent heat. Above the evaporators are feed water heaters of an unusual design known as a double-pipe, enclosed type in 3 sections which deliver the water to the boilers and evaporators at a high temperature; the heat supply is the reboiled water on its way to the flat coolers, the condensate from the generators on its way to the reboiler, and the condensate from the evaporators passing to the reboiler.

Water for the Plant

The water supply is taken from 2 wells each 190 ft. deep, but the water rises to within 17 ft. of the ground level. Air lift pumps deliver the water to a pump forces the water through condensers, etc., the 1500-cistern from which an 800-g. p. m. motor-driven centrifugal pump or a Dean Bros. 16 by 10 by 14-in. simplex g.p.m. Fetta water softener taking its supply from the waste cooling water works on the continuous system and treating the water at about 110 deg. F. Three reserve tanks are provided for holding the treated water until fed to boilers and evaporators.

Compressed air for operating the wells and ice hoists and for cleaning coils is supplied regularly by a Blaisdell, duplex, steam driven, air compressor, 12 by 12 by 12 in., delivering air at 80 lb. pressure. For emergencies a small belt driven Curtis air compressor is used; its capacity is not sufficient to do all the work of the plant but will insure power for operating hoists.

Electric current for operating motors and furnishing lights is generated by a 60-kw., 220-v., 3-phase General Electric Co. alternator driven by a 14 by 14 in., Chandler & Taylor engine at a speed of 300 r. p. m.

Ice Machines

The ice-making machinery is all the product of the Carbondale Machine Co. and consists of 2 machines each rated at 50 tons of ice in 24 hr. All exhaust from engines and pumps passes through 10-in. coil separator before entering the ammonia generators which put a back pressure of 5 to 10 lb. on the engines and pumps. The generators are 45 in. in diameter and 21 ft. long and work under an ammonia pressure of 125 lb. under normal conditions. The ammonia pumps are of the simplex type 14 by 7 by 16 in.

In order to save floor space, the condensers and absorbers are placed one unit above the other. These are all of the double pipe construction. Each condenser consists of 10 stands 5 pipes high and 20 ft. long made up of 3 and 2-in. pipes. The absorbers are each made up of 10 stands 4 pipes high, 20 ft. long consisting of 3 and 2-in. pipes. The design of these is such that the weak liquor has an injector effect in drawing the ammonia gas, which hastens the absorption.

Tube Cleaning Process

Well water at Indianapolis is very hard and considerable difficulty had been experienced in keeping the condenser surfaces clean. It had been customary to use a tube scraper for this purpose in addition to reversing the flow of water at frequent intervals, but the labor involved and the reduced capacity during clean-

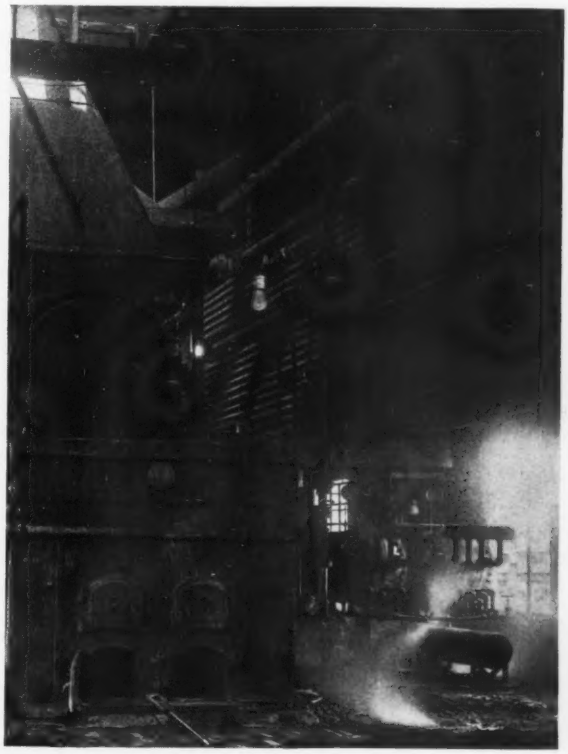


FIG. 2. EVAPORATORS AND DOUBLE PIPE HEATERS AND ONE END OF BATTERY OF BOILERS

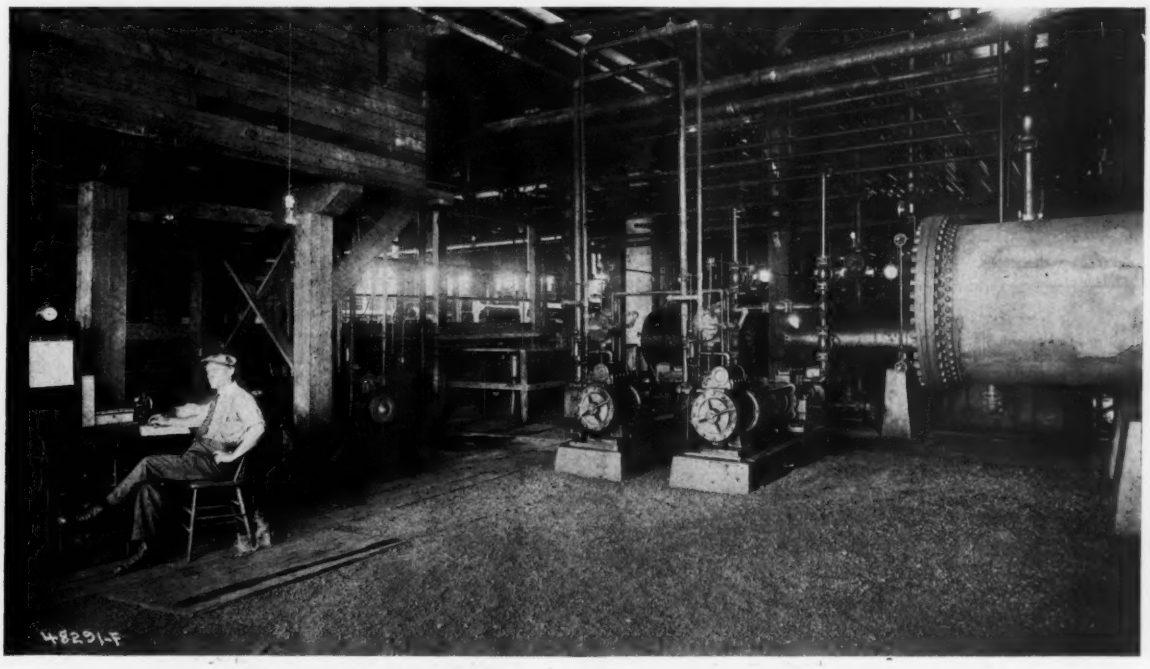


FIG. 4. VIEW IN MACHINE ROOM SHOWING FORE COOLER AMMONIA PUMPS, END OF GENERATOR WITH CONDENSERS AND ABSORBERS IN BACKGROUND

ing time involved losses that were seriously objectionable. The sediment formed is not hard but more like slime and makes a very poor heat conductor. The engineer in charge devised a scheme for turning compressed air into the wash water, reversing the flow through each stand separately. This has worked exceptionally well in keeping the tubes clean; it takes but a comparatively short time and does not reduce the capacity appreciably during the operation, with the result that higher efficiency is maintained continuously. Tubes are cleaned in regular operation once a week. This scheme is now being arranged for on all double pipe parts.

In this plant it will be noted that the double pipe system has been employed in nearly all the heat exchanging machines, the exceptions being the exchangers, of which there are 4 shell type and the 4 tubular brine coolers in the ice tanks. The flat coolers are double-pipe 4 stands, 6 pipes high and 20 ft. long of 3 and 2-in. pipes. These give an initial cooling to the water as it goes to the fore cooler which is a tank 17 ft. 6 in. by 7 ft. by 6 ft. From here the water is fed by gravity through sponge filters of which there are 4, to the ice cans in the freezing tanks.

Freezing Tanks and Storage Rooms

An interesting feature of the freezing tanks is that they contain no coils. The calcium brine is circulated through 2 brine coolers of the tubular type in each tank, these are placed at one end of the tank where 2 agitators driven by belt from a motor give the necessary circulation of the brine, which is directed by properly placed baffles in the tanks. Each tank is 83 ft. 4 in. long, 27 ft. 4 in. wide, and 48 in. deep; the total capacity of the tanks is 1616 300-lb. cans, and the normal rate of freezing is 40 hr.

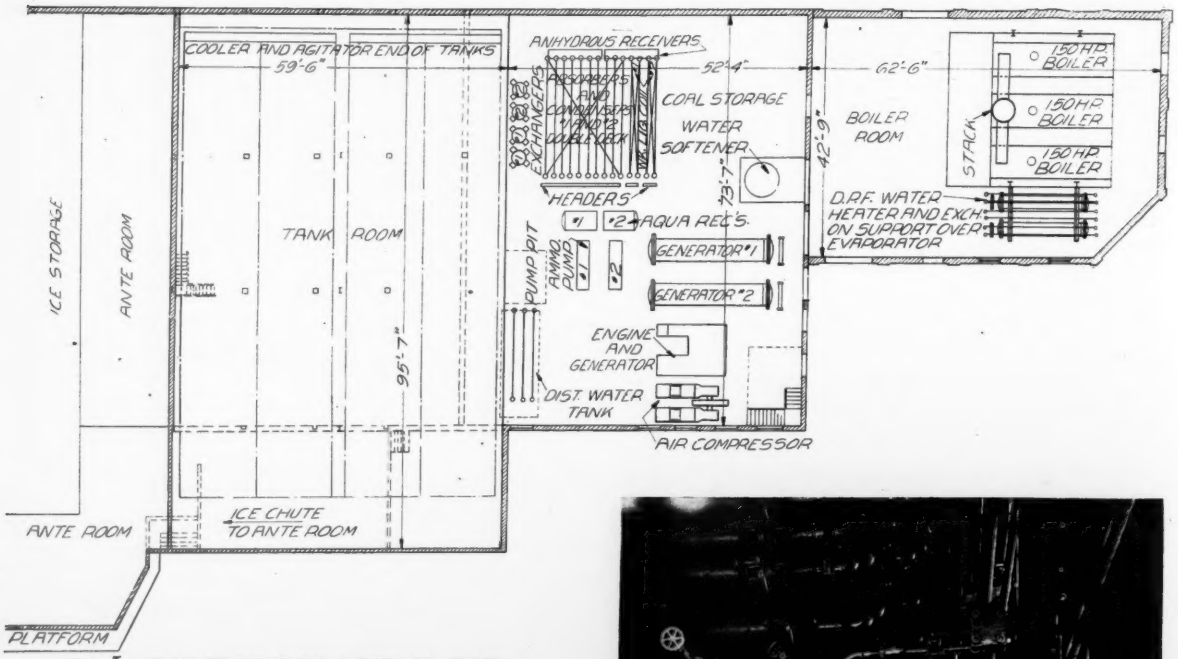


FIG. 5. PLAN OF POLAR ICE & FUEL CO. PLANT

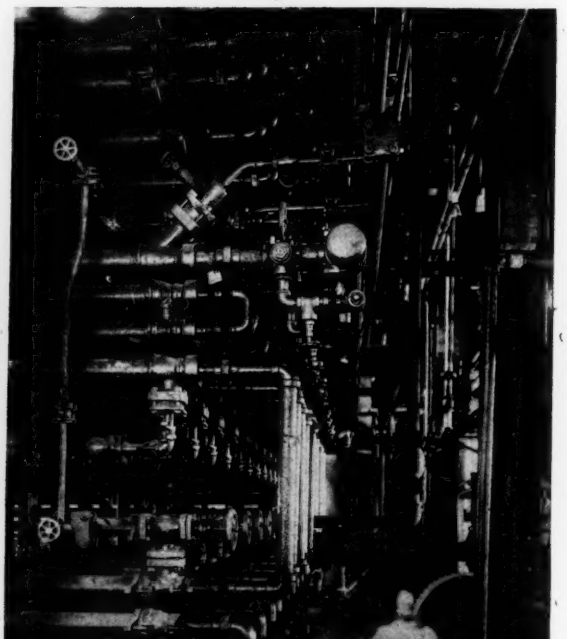


FIG. 6. END OF CONDENSER AND ABSORBER

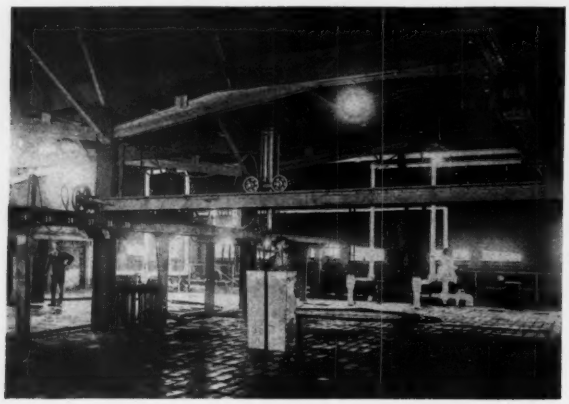


FIG. 7. FREEZING ROOM SHOWING BRINE PUMPS IN THE REAR

Cans are lifted by Curtis air hoists mounted on cranes that take them to the can dips furnished with water from the flat coolers. The plant has a daily storage of 1000 tons capacity and a storage for extra supply of 3000 tons. These storage rooms are cooled by brine coils, the brine being pumped from the freezing tanks by 2 9 by 6 by 12-in. pumps forced through the coils and returned to the tanks through double-pipe brine coolers at the tank temperature. The small room has 7000 ft. of 2-in. pipe and the large room 12000 ft. all overhead; the load represented here is about 20 tons of refrigeration or 10 tons of ice a day.

While the rating of the plant is only 100 tons of ice in 24 hr. it will be noted on the accompanying log sheet that the output on one of the heavy days last summer went up to 147.6 tons and this, it should be stated, was before any of the pipes were insulated. Better results are expected during the coming season than are shown by this log, for a number of improvements have been made during the present shut down period.

THE FELLOW who sits still and does what he is told to do, will never be told to do big things. Think beyond your job! Nothing is more fatal to success than taking your work as a matter of course. The surest way to qualify for the job just ahead is to work a little harder than anyone else on the job which one is holding down. Don't be afraid to start at the bottom. Bare hands grip success better than kid gloves.

CHARLES M. SCHWAB.

POLAR ICE & FUEL CO.

North Plant — **Log for 24 hours ending 6 A. M.** AUGUST 18, 1916

Time	Boilers in Operation	Steam Pressures: Boiler	Steam Pressures: Evaporator	Steam Pressures: Exhaust	Ammonia Pressures: Generator No. 1	Generator No. 2	Absorber No. 1	Absorber No. 2	Brine Cooler No. 1	Brine Cooler No. 2	Rectifier Temperature No. 1	Rectifier Temperature No. 2	Brine Temperature No. 1	Brine Temperature No. 2	Distilled Water at Ice Cans: Appearance	Distilled Water at Ice Cans: Tem.	Boiler Feed Water Temperature	Temp. of Water at Weak Aqua Coolers No. 1	Temp. of Water at Weak Aqua Coolers No. 2	Inches Liquid Anhydrous in Receivers No. 1	Inches Liquid Anhydrous in Receivers No. 2	Time of Blowing Down: Boilers	Time of Blowing Down: Evaporators	Water Softener: Chemical Put In	Water Softener: Flushed	Agitators	Temperature Storage	Pounds Coal Burned
7 AM	2-3	110	80	9	130	128	11	10	18	15	110	110	13	14	CLEAR	50	170	77	76	10	13	6.40						
8	"	110	80	9	130	125	11	10	18	15	110	110	13	14	"	52	172	77	76	11	15		7.40	7.40	7.40	OK		
9	"	112	80	10	130	127	11	9	18	15	110	110	13	13½	"	52	168	78	77	12	15					"		
10	"	110	80	10	130	125	11	9	18	15	110	110	13½	13½	"	52	164	78	77	13	15					"		
11	"	110	80	10	130	127	11	9	18	15	109	109	13½	13	"	52	170	78	77	14	16					"		
12 M	"	114	80	10	130	127	11	9	18	15	109	109	13½	13	"	52	172	78	77	14	16					"		
1 PM	"	112	80	10	130	127	11	9	18	15	109	109	13	12½	"	52	164	78	77	15	15					"		
2	"	114	80	10	130	127	11	9	18	15	109	109	13	12½	"	53	168	78	77	14	13					"		
3	"	112	80	10	132	127	11	9	18	15	109	109	13½	12	"	51	162	78	77	10	13					"		
4	"	112	80	10	132	127	11	9	18	15	109	109	13½	12½	"	49	164	78	77	9	10					"		
5	"	114	80	10	135	128	12	14	19	19	109	109	14	13	"	49	168	78	77	9	8					"		
6	"	114	80	10	135	130	12	14	19	19	109	109	14	13½	"	50	162	78	77	12	8					"		

Engineer Day Shift

No. of Blocks Ice Pulled No. 1: 254 Letter and No.

No. of Blocks Ice Pulled No. 2: 218 Letter and No.

Total Pounds Coal Burned on Day Shift

To One

7 PM	2-3	112	80	11	135	129	12	13	19	18	109	109	14	13	CLEAR	47	168	78	77	13	20					OK		
8	"	112	80	11	135	129	12	13	19	18	109	109	14	13	"	47	172	78	77	13	18					"		
9	"	112	80	11	135	129	12	11	19	18	109	109	13½	13	"	47	170	78	77	13	15		9.20	9.20	9.20	"		
10	"	112	80	11	135	129	12	11	19	18	109	109	13½	13	"	47	168	78	77	13	15					"		
11	"	112	80	11	135	129	12	11	19	18	109	109	13½	13	"	48	172	78	77	13	14					"		
12 M	"	112	80	11	135	129	12	11	19	18	109	109	13½	13	"	47	168	78	77	13	14					"		
1 AM	"	112	80	11	135	129	12	11	19	18	109	109	13½	13½	"	47	170	78	77	13	14					"		
2	"	112	80	11	135	129	12	11	19	18	109	109	13½	13½	"	47	172	78	77	13	14					"		
3	"	112	80	11	135	129	12	11	19	18	109	109	14	14	"	47	170	78	77	13	14					"		
4	"	112	80	11	135	129	12	11	19	18	109	109	14	14	"	47	170	78	77	13	14					"		
5	"	112	80	11	135	129	12	11	19	18	109	109	14	14	"	47	168	78	77	13	14	5.20	5.20	5.20	5.20	"		
6	"	112	80	11	135	129	12	11	19	18	109	109	14	14	"	48	172	78	77	13	14					"		

E. FROST. Engineer Night Shift

No. of Blocks Ice Pulled No. 1 250 Letter and No.

No. of Blocks Ice Pulled No. 2 262 Letter and No.

Total Pounds Coal Burned on Night Shift

Total Pounds Coal Burned in 24 Hours

Remarks in space below:

Total No. of Blocks Ice Pulled 984 = 147.6 TONS

To One

FIG. 8. LOG OF PLANT SHOWING ONE DAY'S OUTPUT AND OPERATING CONDITIONS MAINTAINED

Fire Brick Linings of Boiler Furnaces*

PHYSICAL AND CHEMICAL QUALIFICATIONS AND CHARACTERISTICS TO BE CONSIDERED IN SELECTION OF BRICKS

IT WAS formerly considered good practice to place the heating surface of the boiler as close to the fuel bed as possible. The demand for the elimination of smoke made necessary the construction of large combustion chambers for furnaces using high volatile coals, thus moving the fuel bed a considerable distance from the heating surface.

One result of this development is an increased reflecting and radiating surface of incandescent fire-brick. Another result of these changes and the higher boiler capacities now being obtained is that furnace brick work is now not only subjected to higher temperatures which tend to fuse or at least soften the brick itself, but to abrasion due to the increased flue gas velocities and the impinging or blow torch action of the flame. The reflecting and radiating surfaces of arches, walls and roofs are in addition coated and even washed with the slag from the ash, especially when low grade coals are burned. If furnace temperatures are sufficiently high this slag will run, while with lower temperatures it becomes a gummy, spongy mass which adheres to the side walls and other parts of the furnace and interferes with the proper operation of the stoker. This slag must be removed manually, which invariably results in damaging the furnace lining to a greater or less degree.

Many schemes for ventilating furnace linings have been tried out with the idea of cooling certain parts of the brick faces exposed to the fire to prolong their life. As this practice is contrary to the basic principle of furnace efficiency and capacity, it has been generally discarded, since best results can be obtained only by maintaining high temperatures on all surfaces of the brick work exposed to the fire.

The question of the grade of brick best adapted for use in furnace walls and arches is one that has been extensively investigated by both manufacturers and users, but in spite of this the station engineer is frequently at a loss to know what material should be selected to suit best his requirements. The general classes of fire brick available for furnace work include, pure silica brick, magnesia brick, chrome brick, bauxite brick and fire clay brick. Each of these classes has certain essential characteristics, but experience in boiler work has shown that fire clay brick fulfill better the requirements of infusibility, absence of shrinking or deformation, strength, and resistance to vapor and slag penetration.

Fire clay brick can be further subdivided from a chemical standpoint, and a silica alumina mixture is preferable to a silica kaolin mixture, and is generally offered by manufacturers as most suitable for this class of service.

After considerable experience with various materials for furnace linings, some of which have been recommended by manufacturers as having especially high refractory qualities, it has been found that there are certain physical qualities which are equally as important as the chemical characteristics in determining the ability of brick to withstand severe service. The first requirement of fire brick is that they must be of uniform size and true in shape, so that perfect joints can be made. It is in the joints that abrasion due to flue gas or molten slag first takes place, and the buttering of a wide joint with fire clay does not suffice, as the fusibility of the clay is low compared with that of the brick.

The quality of the fire clay used in laying the brick has a direct bearing upon its life. Where fire clay of inferior quality is used it will tend to fuse within the joint and in so doing cause the side of the brick with which it is in contact to melt. In case the joints are irregular due to poorly shaped brick, it is advisable to mix fine ganister with raw clay to prevent shrinkage.

In arches, particularly, brick of uniform size with plane surfaces are absolutely necessary, because crooked or uneven brick will cause failure due to uneven strain occasioned by expansion and contraction. Great care must be taken in setting and backing up the skew-backs in order that the arch may have a sufficiently rigid and true support. A common cause of arch collapse in new furnaces is the moving of the skew-back by the initial heating before it has arrived at its final set. Another occasional cause of arch failure is the wetting through of the brick from leaky piping or some other cause. Heat applied too suddenly to imperfectly dried brick leads to serious spawling. Similarly, when cold air is allowed to come in contact with hot brick-work there is a sudden lowering of the surface temperature and unequal strains are set up which cause parts of the brick to crack or spawl.

For sidewalls, bridge walls and other parts of the furnace where slag is most apt to collect, the brick must be sufficiently hard and possess sufficient mechanical strength to resist not only abrasion but the chipping or slicing action due to the removal of this slag by manual labor at more or less frequent intervals. They must be burned to a temperature in excess of that met with in the furnace. On the other hand, if the structure of the brick is too dense, the danger of spawling is increased, due to the increased cofficient of expansion. This applies particularly to arch work where the great range of temperature demands a low temperature coefficient to reduce as much as possible the danger of warping and cracking.

The material from which the brick is made should also be free from fluxing impurities, such as iron, lime, magnesia and coarse flint particles, which tend to lower the degree of refractoriness and have a detrimental effect on the serviceability of the brick. In the selection of the most suitable fire brick other physical characteristics, such as uniformity of mixture, color, size of the composite particles, degree of burning and density, can profitably be considered. A material of high density or too compact a mixture will generally spawl. The color of the material is generally an indication of the presence of foreign mineral matter. Brick having a loose structure will readily spawl, since in such material

*Taken from report of Committee on Prime Movers, of N. E. L. A.

there exist cleavage lines along which the cracking occurs during the process of heating and cooling.

The consideration of the relative values of various fire brick material from the standpoint of their chemical composition only is a doubtful guide to the best results. The physical characteristics, other things being equal, and the actual service of the manufactured article are the only reliable tests. Chemical analyses submitted by manufacturers or those found in official geological surveys on clays used in the making of fire brick contain such a varying range of percentage for each constituent element that any attempt to come to a logical conclusion only leads to confusion. Again, analyses may not be a true indication of the actual commercial product, because the clay deposits are not uniform in their chemical composition but vary considerably from time to time. The process of manufacture of the material may also vary.

In general, the fire brick manufacturers have not kept pace with the development of boiler and furnace construction and operation, so that the item of furnace repairs in the operating cost is not being reduced along with the other items in that expense. They have been slow to appreciate the increase constantly being made in boiler operating capacities and efficiencies with increasing furnace temperatures and flue gas velocities and increasing severity in general furnace conditions. In addition, in the Middle West particularly, the amount of fire brick required in furnace construction is increasing, so that the difficulties are further enhanced.

Coal and Ashes Handling and Storage--II

LIFTING COAL AND ASHES TO ACTIVE STORAGE BINS WITH TYPICAL BUCKET CONVEYOR AVOIDS DIRT AND DRUDGERY. BY HENRY J. EDSALL

WHILE THE AMOUNT of ashes to be handled at a power plant is usually only about 10 per cent of the amount of coal handled, except where anthracite coal is used, when it runs up to about 20 per cent, still the proper handling of the ashes is a very important matter, since, on account of the heat, and dust, and the steam when the ashes are quenched, it is very unpleasant work at best, so that it pays to make it as easy as possible and avoid trouble with labor in looking after this part of the plant operation. In the modern power plant the ashes are usually dropped into hoppers underneath the stokers and handled to a conveyor or car in the basement, and in this way the dirt and confusion are avoided on the operating floor.

BUCKET CONVEYORS

SINCE simplicity in equipments for handling coal and ashes is surely a virtue, it has, almost from the first, been the aim of the engineer to elevate and distribute the coal and dispose of the ashes, all with one machine. While some of the earlier machines for this work were certainly failures in their ability to withstand this severe service, this is now "ancient history," and the best modern practice in nearly all plants, except some of the very large ones, is to use a first-class pivoted bucket carrier traveling in a rectangular path, with the upper run above the coal and ashes bins, and the lower run in the basement, where the ashes can be raked into it. In this way all the elevating and conveying of coal and ashes is done with one machine, and there is not the least doubt about the best modern carriers being able to withstand this service and show a low maintenance cost, since this is the method used with the greatest satisfaction in many of the best power plants in the country.

For such a carrier a diagram is shown in Fig. 1, and a typical arrangement of a power plant equipped with such a machine is shown in Fig. 2. It will be noticed that the buckets have overlapping lips so that they can be loaded anywhere along the horizontal run without the material spilling through between them, and that they always retain their load-carrying position until dumped by the discharger, so that the material is elevated and discharged at any point desired. These machines are usually made with chains 18 or 24 in. pitch and buckets about 18 or 24 in. wide, although they are frequently larger than this. The speed of travel is very slow, usually about 40 ft. per min., and at each joint the chains have good-sized rollers, which travel on tracks on the horizontal and inclined runs, and between guides on the vertical runs, so that the power required is small.

Chains and buckets are made of malleable iron which withstands the corrosive action of wet ashes remarkably

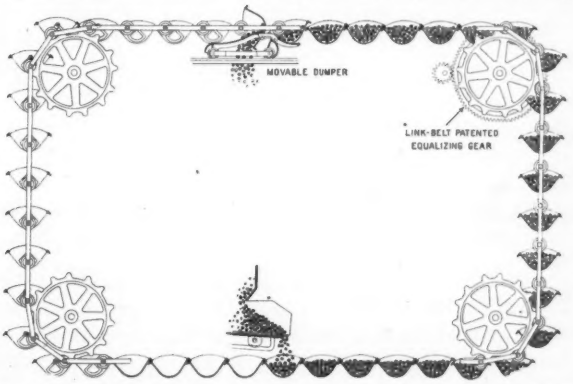


FIG. 1. DIAGRAM OF ARRANGEMENT OF PIVOTED BUCKET CONVEYOR

well, and the chain joints are made with case-hardened steel pins and bushings, which take all of the wear, so that none of it comes on the links, and since these pins and bushings have large bearing surfaces and are thoroughly oiled from an oil chamber in the rollers, the wear is very slow.

STORAGE BINS

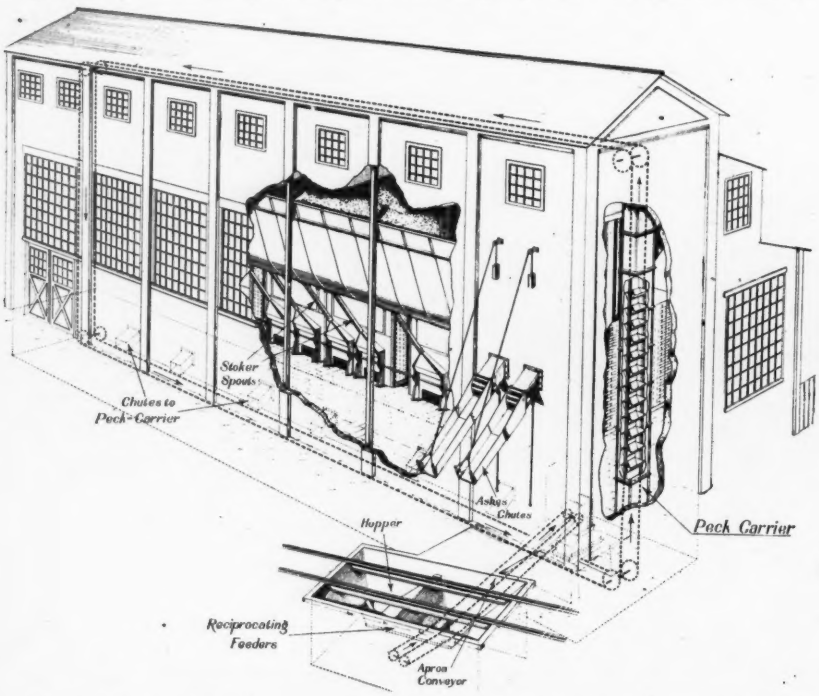
IT WILL be noticed in Fig. 2 that the coal bin is of the suspended type, with girders running along the upper edge of the bin longitudinally, and plates below these girders. This avoids the necessity of supports underneath the bottom of the bin, as the load is all carried by the girders along the top edge. This is the most

economical form of bin, in the amount of steel required, that has been designed up to the present time, and it is used a great deal.

Sometimes these bins are lined with concrete or other material to avoid corrosion, and in one design the body of the bin is built of reinforced concrete, with straps or saddles hung from the girders at the top edge so as to take the majority of the weight. As a matter of fact, however, most of these bins are built with only the steel plates, and, if it is desired to increase their length of life further, it would seem more logical to add a little to the thickness of the steel plate rather than to go to considerably greater expense for concrete or other lining, or a reinforced concrete bin, especially as there is a possibility of the reinforcing deteriorating by the what the size of the lumps may be, and in this way the crusher receives a regular feed and does not become choked, so that it can be driven with a moderate amount of power.

Stoker Supply

In Fig. 2 the coal is spouted direct to the stokers, and this is probably the most common practice, though the traveling weighing hopper is becoming popular of late. This machine consists of a hopper supported on scale beams, which, in turn, are supported on a steel frame fitted with wheels that travel on tracks underneath the bin, so that the coal can be drawn into the weighing hopper and weighed by the operator before it is delivered, by means of a chute, to the stokers. These hoppers are usually equipped with a motor for moving



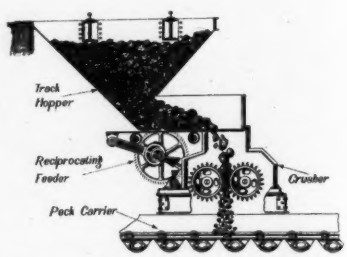


FIG. 3. TRACK HOPPER, FEEDER AND CRUSHER FEEDING TO CONVEYOR

FIG. 2. BOILER HOUSE WITH BUCKET CONVEYOR FOR HANDLING COAL AND ASHES TO OVERHEAD BINS. GRAVITY FEED TO STOKERS, JOHN A. ROEBLING'S SONS CO.

percolation of moisture through the concrete. In Fig. 2 the ashes bin is indicated as of concrete, and these bins are nowadays usually built of concrete or concrete and brick, since the deterioration of steel plate from wet ashes is quite rapid.

Track Hopper

The track hopper is in a pit below the ground level, so that the cars can be placed over this hopper and the coal dumped into it. The coal is then fed direct or by an apron conveyor to a reciprocating feeder to a two-roll crusher and goes through the crusher into the carrier, which elevates it and distributes it in the overhead bin. The ashes are raked from the ashes hoppers into the lower run of the carrier and taken up and delivered to the bin over the railroad track, from which they can be delivered to railroad cars at any time desired.

By the use of a reciprocating feeder, Fig. 3, underneath the bottom of the track hopper, the coal is fed regularly and automatically to the crusher, no matter them, though some of them are moved by a hand chain and gearing. This type of weighing device is used ordinarily for weighing only the total amount of coal used, since to weigh the coal for each stoker becomes too cumbersome.

Another method of weighing coal, which has become quite popular is to equip the spout to each stoker or each unit, say 2 to 4 stokers, with an automatic scale of the self-recording type. These machines automatically record the amount of coal which passes through them, so that a record is kept of the amount of coal used, and the amount used by the different units can be compared from time to time; if the steam output of each unit is also recorded, it can be easily seen what efficiency each one is giving.

Typical Plant

In the example of actual equipment just described, Fig. 2, which illustrates a power plant under construction for the John A. Roebling & Sons Co., Trenton, N. J., the main coal and ashes conveyor is a 24 by 24

in. Peck pivoted bucket carrier, following a rectangular path, having horizontal centers of 131 ft. and vertical centers of 61 ft., and being driven by a 10-hp. motor.

In order to avoid moving cars when unloading on the rather cramped track room, the track hopper is made double so that it is 12 ft. wide across the track and 22 ft. 9 in. long parallel to the track. Underneath each side of the track hopper is a reciprocating feeder which consists of a plate that is given a reciprocating or back-and-forth motion, so that the coal moves forward with the plate while other coal moves down at the back, and as the plate moves back the coal at the forward end falls off onto a 30-ft. center apron conveyor 30 in. wide, which takes the coal up an incline and delivers it to a two-roll crusher. The apron conveyor consists of corrugated steel pans attached to two strands of roller chain so as to form a continuous apron.

The crusher has chilled cast iron rolls 28 in. in diameter by 24 in. face, and the apron conveyor and crusher are all driven from a 15-hp. motor, while the double reciprocating feeder is driven from a 5-hp. motor.

After the coal goes through the crusher, it goes into the carrier buckets which elevate it and distribute it in the overhead coal bin, from which it is spouted direct to the Wetzel stokers.

Ashes drop into hoppers underneath the stokers and are then raked out into the carrier buckets, which take them up and deliver them to the overhead ashes bin at one end of the building, whence they are spouted out to railroad cars. The carrier is to operate at a speed of 45 ft. per min. and to have a capacity of 60 tons per hour of coal or an equivalent amount of ashes. The boilers are of the Edge Moor type in 600-hp. units, set in batteries of 2 each, and when all the boilers are installed, there will be a total of 3600 hp.

Flight Distributing Conveyors

In Fig. 4 is shown a boiler house for the Citizens Gas & Electric Co., Waterloo, Iowa, in which the coal and ashes will be elevated by pivoted bucket carriers, the ashes being delivered to an overhead bin for spouting to railroad cars, and the coal being delivered to roller flight conveyors running over the bins at right angles to the carriers and distributing the coal in these bins. The ashes will be handled from the hoppers under the stokers to the carriers by means of industrial cars. Only one-half of this power plant will be built at the present time, and only one carrier and one flight conveyor will be installed.

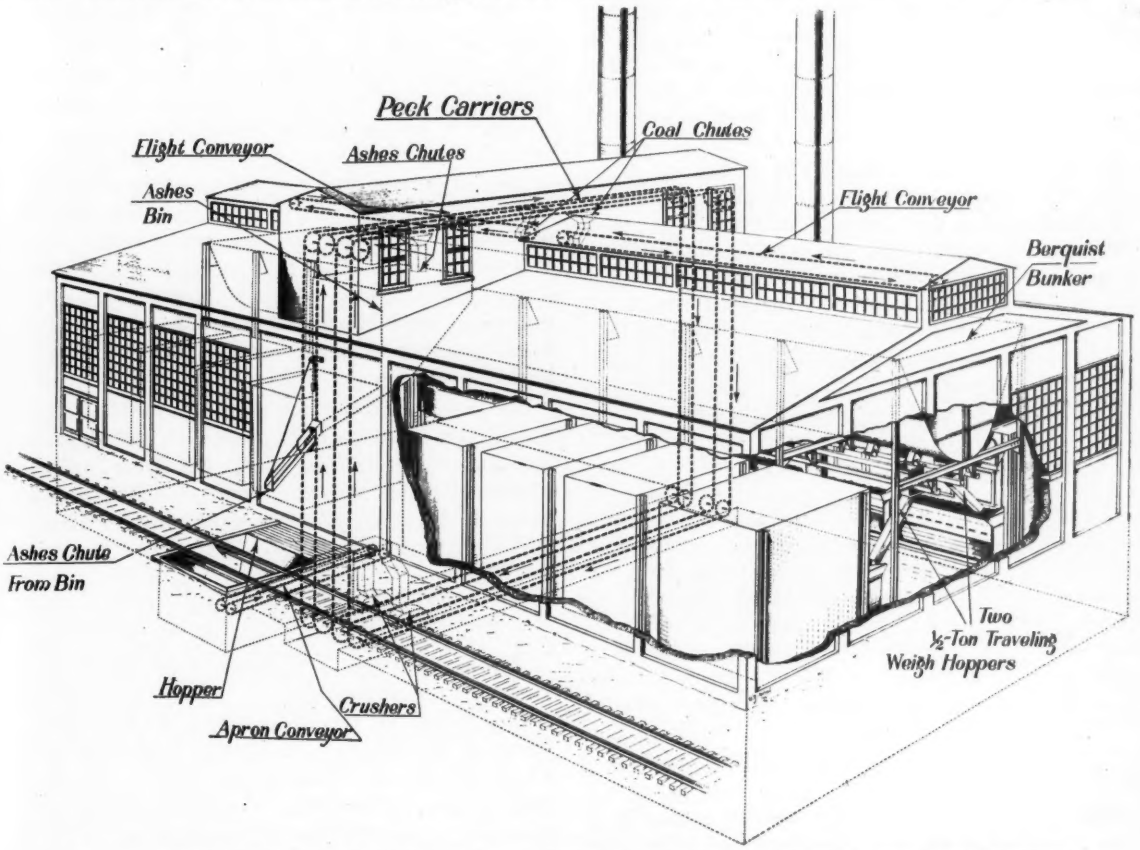


FIG. 4. PLANT WITH BUCKET ELEVATORS AND FLIGHT DISTRIBUTORS. CITIZENS GAS & ELECTRIC CO., WATERLOO, IA.

The track hopper is to be 18 ft. long by 14 ft. wide and made of ¼-in. steel, properly braced with angle stiffeners. Underneath this track hopper will be an apron feeder 30 in. wide and 21 ft. centers, which will transfer the coal and deliver it to a 2-way chute, one side of which feeds to a 2-roller crusher over the present carrier, while the other side will deliver to a future two-roll crusher over the future carrier. The crushers will have rolls 26 in. in diameter by 30 in. long, each crusher being driven by a 15-hp. motor. The apron

feeder will be driven by a 3-hp. motor to operate at a speed of about 8 ft. per min. The carriers will have standard 24 by 24-in. buckets, following a rectangular path of 74 ft. vertical centers of 84 ft. horizontal centers at a speed of 50 ft. per min., giving a capacity of 60 tons of coal per hour, or an equivalent amount of ashes.

Roller flight conveyors will have flights 19 in. long by 8 inches deep, spaced every 24 in., each conveyor being 86 ft. centers and operating at a speed of 100 ft. per min. A 7½-hp. motor will be used to operate each conveyor by a gear train to sprocket shaft.

Coal bins will be built of steel, of the suspended type, supported on steel columns. Underneath the bin will be two ½-ton, motor-operated, traveling weighing hoppers for delivering to two rows of boilers. The first half of the plant to be built will have space for eight 600-hp. boilers, or a total of 4800 hp., so that when the future half of the plant is added, there will be a total of 9600 hp. The stokers in this case will be Green Chain Grate type.

Unaflow vs. Counterflow as to Economy

By A. C. Ruhl

WHETHER the unaflow engine is a better engine to buy than the old reliable counterflow is a question that is unsettled in the minds of a good many engineers. The unaflow engine is not new. A Mr. Todd, of England, took out a patent on a unaflow engine in the year 1885, but it is an assured fact that his engine of that time was not a success; why it was not is not known, but it probably was due to the suspicious minds of the engineers of those days. Todd had some queer ideas about his engine, and one of them was that the excessive compression would be minimized by the radiation of the cylinder walls and for that reason the cylinder should not be steam jacketed or heat insulated. This one point shows that Mr. Todd did not understand his own invention.

As it is built today in this country the unaflow engine is one of the simplest engines on the market; having only one cylinder, 2 steam valves, and one eccentric.

In our plant the 33 by 36-in. unaflow engine has at normal load a cutoff of 2 in.; that is, the piston travels only 2 in. of the stroke when cutoff takes place, the engine developing its normal or rated load. Compare this performance with a 4-valve counterflow Corliss engine which would have a cutoff of ¼ stroke, or, for the same length of stroke and speed, would take steam until the piston travels 9 in., when cutoff would occur. Why is it that a unaflow engine can do with a cutoff of 2 in. the amount of work which a Corliss counterflow does with 9 in.?

This comparison is based on a unaflow engine 33 by 36 in., a simple Corliss counterflow engine of 24 by 36 in. and a cross-compound Corliss counterflow of 18 by 36 by 36 in. all at 125 r.p.m.

At the point of cutoff, namely, 2 in. of the stroke, the cubical contents of the unaflow cylinder is 1710 cu. in., neglecting clearance. On the cross-compound Corliss counterflow engine the cubical contents of the high-pressure cylinder with a cutoff of 9 in. is 2286 cu. in., also neglecting clearance.

We have here a difference of 576 cu. in. of steam per stroke, or in one hour 5000 cu. ft. of steam more for the counterflow with 2 cylinders than the unaflow with one cylinder. If both engines are rated at 600 hp., the Corliss counterflow will use 3 lb. of steam more per hp.-hr. than the unaflow.

*From a paper presented at a meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers.

The unaflow engine extracts the energy from the steam the same as any ordinary counterflow steam engines, namely, by pushing the piston head until exhaust occurs, but right at this point is where it differs from counterflow steam engines; instead of the exhaust valve opening the exhaust port to let the steam escape to the atmosphere or condenser as the case may be, the piston of the unaflow engine travels on, opening the exhaust port to the atmosphere or condenser the same as in the counterflow type. This opening of the exhaust occurs about 5 in. from the end of the stroke and continues until the piston has traveled 5 in. of its return stroke when the piston closes the exhaust port and compression begins.

Instead of the piston driving the steam towards the exhaust opening, it compresses the steam ahead of it and when running condensing with 26 in. of vacuum this compression reaches a point of from about 80 lb. up to initial steam pressure, depending on the amount of clearance in the cylinder. The higher the compression the more economical is the engine, only the compression should not be above the inlet pressure, but should be within 5 or 10 lb. of it. The ideal compression would always be equal to the initial pressure.

In the counterflow type of cylinder the driest steam goes out through the exhaust and the wet steam just ahead of the piston is entrapped and compressed to about 5 to 20 lb. What is the result? The clearance space of the counterflow is filled with mist of about 25 lb. pressure; the steam valve opens, admitting steam to this space filled with wet steam at low pressure; consequently a large amount of the initial or incoming steam is condensed in raising the temperature of this entrapped steam to the temperature of the incoming steam. Not only this but the walls of the cylinder and the piston are also at this low temperature, taking more heat from the initial steam to get these walls up to the same temperature as the steam.

In giving up heat this steam is losing energy, but this energy is not shown on the indicator card and is a total loss. This flowing of heat from the steam to the cylinder walls causes the steam to give up part of its latent heat, and as saturated steam cannot lose any of its heat without condensation we find the cylinder walls are covered with a film of moisture, and this is known as initial condensation. This condensate in

simple engines may be as high as 25 per cent or more of the entering steam.

Although metal is a good conductor of heat it cannot give up or absorb heat instantly, consequently during expansion the temperature of the steam falls more rapidly than that of the cylinder. This allows heat to flow from the cylinder walls to the moisture on them. As fast as the steam expands, so that the pressure in the cylinder becomes less, this condensation will begin to evaporate, and, as the pressure continues to fall, it requires less and less heat to form steam; therefore a good part of this moisture is evaporated into low-pressure steam. Especially is this true at the end of the cylinder. At release the pressure drop is very sudden, reducing the pressure, and as the cylinder walls are hotter than the temperature due to that pressure, re-evaporation will continue throughout the exhaust stroke and rob the cylinder walls of more heat. What becomes of this newly formed steam? The exhaust valve is open, and it blows out through the exhaust port doing no work, but possibly retarding the piston in its advance by causing a higher back pressure. The exhaust valve closes and compression is raised, as stated before, to about 10 to 25 lb. and the cycle of events is repeated, always with a heavy loss of steam.

If we follow the action of the unaflow, an altogether different performance will be noticed. In a correctly designed unaflow cylinder instead of the incoming steam coming in contact with a steam pressure of from 5 to 25 lb. and a low temperature, we find a steam pressure and temperature nearly the same as the initial or boiler pressure and of course initial condensation is not found here. The indicator diagram shows the expansion to be nearly an adiabatic for saturated steam and the compression line to be nearly an adiabatic for superheated steam; this is the best proof obtainable of the excellent thermal action of the unaflow engine. The excessive initial condensation in a counterflow engine using saturated steam causes the expansion line to follow approximately the law of Mariotte.

In the unaflow engine using saturated steam there is no initial condensation, provided the cylinder is so designed that the compression pressure is equal to the initial or boiler pressure, so that the resulting expansion line is approximately adiabatic; and it is more nearly so if superheated steam is used. As shown by the approximate adiabatic line, there can be very little re-evaporation, as the moisture fraction of the steam after expansion is very low.

The cylinder head being steam jacketed, exercises a considerable heating effect on the expanding steam, owing to the difference in temperature between the head and the expanding steam; this transfer of heat occurs principally to the steam immediately in contact with the head. The steam following the piston has a definite fall in temperature and increase in wetness, and the greatest wetness in the expanding steam is therefore found in the layer immediately following the piston. In the layers between the piston and the head the wetness decreases towards the head and the steam in contact with the head may be superheated. On opening the exhaust port the wettest steam is ejected into the exhaust cavity and the dry steam from the head will follow until the piston closes the exhaust port.

The steam which received heat during the entire time of expansion and exhaust and was subjected to the action of the full temperature difference between the expanding steam and the heating head is entrapped by the piston and compressed, which compression will now approximate very closely to that of the adiabatic for superheated steam. This approximation to the adiabatic for superheated steam is still further affected by the fact that during the first part of compression, further heat is transmitted from the head to the steam under compression, and as all the moisture is completely removed at each stroke of the piston the expensive heat losses caused by the water in the counterflow engine are avoided.

TABLE I. ACTUAL RESULTS OF ENGINE TEST

1. Engine, G. & G. Cooper Co., rated output 640 i.h.p. or 440 kw. at switchboard.
2. Cylinder 33 in. by 36 in. Piston rod, head end, 5½ in. diameter; crank end, 5⅝ in. diameter.
3. Clearance, head end 4 per cent.; crank end 3.8 per cent.
4. Boilers, Heine Boiler Co., rated at 200 h.p. each. 2000 sq. ft. heating surface. Dean shaking grates, hand fired. Grate area 39.6 sq. ft.
   Auxiliaries, Dean Bros. Surface condenser and pumps. 1400 sq. ft. cooling surface in condenser.
5. Date, April 25 and 26, 1914.

6. No. or run	1	2	3	4	5	6	7	8	9
7. Duration ....min.	191.	62.	112.	71.	103.	53.	60.	52.	90.
8. Barometric pressure									
(a) in. of mercury	29.34	29.35	29.36	29.40	29.48	29.48	29.50	29.50	29.50
(b) lbs. per sq. in.	14.39	14.40	14.40	14.43	14.48	14.48	14.49	14.49	14.49
9. Steam pressure in supply pipe ....lb.	161.60	162.50	163.90	161.20	158.50	154.20	145.60	125.30	127.50
10. Vacuum referred to 30 in. barometer									
(a) at engine ....in.	23.48	22.67	22.55	20.98	23.56	19.15	23.96	.....	.....
(b) in condensor ....in.	24.61	24.34	24.18	23.77	24.18	23.27	23.32	24.35	23.53
11. Temperature of steam at engine ....deg Fahr.	408.5	422.1	415.0	423.1	410.2	423.1	412.1	381.3	373.3
12. Superheat at engine ....deg. Fahr.	37.2	50.4	42.8	52.3	40.3	55.5	48.5	28.3	19.1
13. Temperature of condensed steam in measuring tanks....deg. Fahr.	106.	110.	113.	122.	96.	126.	92.	83.	.....
14. Temperature of cooling water entering condensor ....deg. Fahr.	76.0	77.2	73.4	72.2	74.5	70.2	77.2	.....	.....
15. Temperature of cooling water leaving condensor ....deg. Fahr.	88.6	88.4	87.4	91.5	82.9	90.7	79.6	.....	.....
16. Temperature of engine room ....deg. Fahr.	80.	78.	80.	80.	79.	81.	86.	.....	.....
17 Steam used by engine during run ....lb.	36201.	20041.	29156.	16086.	16070.	16068.	4070.	2002.	362.
18. Steam used by engine per hr....lb. per hr	8230.	9722.	10708.	13594.	5866.	18190.	4070.	2280.	725.
19. R.p.m. of engine	124.96	124.43	123.92	123.47	125.52	124.23	124.50	124.04	124.30
20. Piston speed of engine ....ft. per min.	749.76	746.58	743.52	740.82	753.12	747.00	745.38	744.24	745.20
Power as measured at switchboard.									
21. Volts	242.5	243.7	243.7	244.5	243.7	244.7	244.7	245.7	.....
22. Amperes	1048.	1212.	1354.	1583.	794.	1050.	535.	270.	.....
23. Kilowatts by watt meter ....kw.	440.8	513.3	555.1	669.2	336.3	815.5	220.2	123.2	.....
24. Steam used by engine under actual conditions of operation, lb. per kw hr.	18.67	18.94	19.45	20.31	17.44	22.31	17.02	18.57	.....
Heat data.									
25. Heat units in each lb. of steam supplied, B.t.u.	1108.	1111.	1106.	1103.	1110.	1093.	1111.	1098.	.....
26. Total units supplied per hr. per kw., B.t.u. per kw-hr.	20380	21060.	21510.	22400.	19360.	24400.	18000.	20380.	.....
27 Thermal efficiency ratio between heat equivalent of kw at the switchboard and heat units supplied in the steam per kw.	16.6	16.2	15.9	15.3	17.6	14	18.	16.8	.....
28. Heat units which would be obtained by perfect (adiabatic) expansion from initial to final pressure per lb. ....B.t.u.	227	272.	271.	258.	275.	243.	267	267.	.....
29. Heat units per kw., B.t.u. per kw.	5170.	5150.	5270.	5250.	4800.	5430.	4550.	4060.	.....
30. Thermal efficiency, per cent.	66.2	66.3	64.8	65.1	71.2	63.0	75.0	68.9	.....

TABLE II. PROBABLE STEAM PER INDICATED HORSEPOWER PER HOUR

I. H. P.	200	300	400	500	600	700	800	900	1000	1100	1200
Steam for one h.p. per hr....lb.	10.25	9.10	9.55	10.4	10.9	11.3	11.8	12.2	12.7	13.0	13.3

Table I is a test of a 33 by 36-in. unaflow engine; the engine was not especially prepared for the test, and the plant was run during the test as in daily operation.

From the values listed in Table II it is apparent that, in the matter of economy, the unaflow engine tested gives remarkably good results.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Motor-Starting Resistances

DESCRIPTIONS AND DIAGRAMS OF CONNECTIONS OF VARIOUS TYPES OF ALTERNATING AND DIRECT CURRENT MOTOR-STARTING DEVICES. BY A. E. WELLS

INSTALLATION of a motor for power purposes, such as driving lathes, drill-presses, pumps, etc., is practically an every-day occurrence. It is, however, rather difficult to find, promptly, the desired and correct diagram for the motor in question. This article, therefore, has been written with the purpose of placing at the immediate disposal of the engineer, a somewhat classified arrangement of the diagrams of connections of the more common starting devices now in use.

When a motor is idle, its armature offers very little resistance to the flow of current. If the motor was to be directly connected to the line, an enormous rush of current would take place in the armature, probably resulting in serious damage. When the motor is running an electromotive force is generated in the armature in a direction opposite to that of the applied electromotive force. This is known as the counter electromotive force, and it is this which prevents an abnormal flow of current when the motor is running. A starting resistance, then, is a device for properly regulating the driving current, until the motor has attained its proper speed.

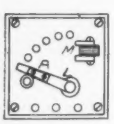


FIG. 1

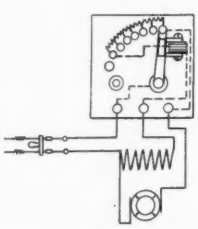


FIG 2

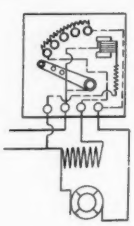


FIG. 3

FIG. 1. EXTERNAL VIEW, COMMON TYPE GENERAL ELECTRIC AUTOMATIC STARTING BOX

FIG 2. EXTERNAL AND INTERNAL CONNECTIONS OF STARTING BOX SHOWN IN FIG. 1

FIG. 3. STARTING BOX HAVING MAGNET AND RESISTANCE CONNECTED ACROSS LINE

Figure 1 is a sketch of the common type of General Electric automatic starting rheostat with no-voltage release consisting of an electro-magnet, M, connected in series with the motor field. Lever, L, is moved over toward the magnet, this motion being opposed by a coiled spring at the fulcrum of the lever. The lever is held in its final position by the armature, A, and the magnet, M, as long as the current is uninterrupted. When the current flow is interrupted, magnet, M, loses its attraction and allows lever L to return to its neutral position. The magnet is connected in the field circuit, rather than in series with the armature, in order that the field circuit cannot be broken until the motor has slowed down in speed. If the field circuit were broken, no more counter electromotive force would be generated, and if the current were to return suddenly a rush of current would take place in the armature.

The proper connections for this type of starting box are shown in Fig. 2. The arm is shown in the position of full speed, with all resistance in series with the field. This is a necessary requirement, for if the field is too strong, an excessive counter electromotive force will be generated, and the motor will not run satisfactorily. It is evident from the diagram that if the switch was to be opened, the field would be weakened, and in a few moments the current flowing through the magnet, M, would not be sufficient to hold the lever in place. Then the coiled spring would cause it to return to its neutral position.

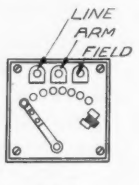


FIG. 4

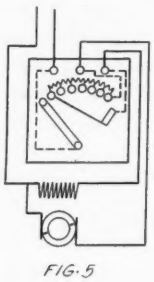


FIG. 5

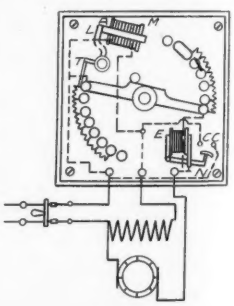


FIG. 6

FIG. 4. EXTERNAL VIEW OF STARTING BOX SIMILAR TO THAT MANUFACTURED BY CUTLER-HAMMER CO.

FIG. 5. EXTERNAL AND INTERNAL CONNECTIONS OF STARTING BOX SHOWN IN FIG. 4

FIG. 6. STARTING BOX WITH AUTOMATIC RELEASE AND OVERLOAD DEVICE

Another type of the General Electric starting box is illustrated in Fig. 3. In this, it will be noted, the magnet is in series with a suitable resistance and the two are shunted across the power line. The connections are practically the same as for the other type, except for the extra connection to the box.

A starting box, made by the Cutler-Hammer Co. has an automatic release similar to the General Electric

starting box, and operate on the same principles. A diagrammatic view of it is shown in Fig. 4. The diagram of connections is shown in Fig. 5, and is so simple as to require no explanation. The contacts are labeled on the box as they are in the diagram, and no difficulty should be experienced in making the proper connections.

Figure 6 shows a General Electric starting resistance with automatic release and overload device that allows the arm to return to its off position under an excessive flow of current. The arm is shown in the running position, and no resistance is in circuit. One advantage of this arrangement of resistance is that the current flows across the contact arm, and does not have to pass through the pivot. The contact lever is held in position by catch T, which fits in a notch in the hub of lever L. This lever has an armature, A, attached to it, held in place by magnet M. The overload protector consists of an electro-magnet E, in series with the motor armature. When the current becomes excessive, armature N is lifted against contacts CC, short-circuiting magnet M. The armature, A, is then released, and a coiled spring in the hub of the contact lever causes it to return to the off position.

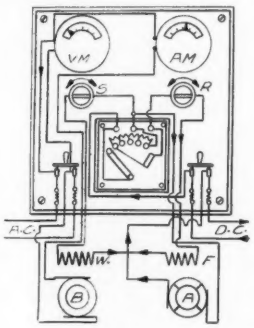


FIG. 7

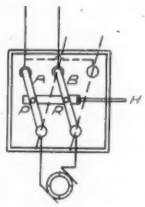


FIG. 8

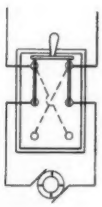


FIG. 9

FIG. 7. DIAGRAM OF CONNECTIONS OF MOTOR GENERATOR CONTROL PANEL

FIG. 8. SIMPLE FORM OF REVERSING SWITCH

FIG. 9. DOUBLE-POLE DOUBLE-THROW KNIFE SWITCH USED AS A REVERSING SWITCH

The method of connecting up a motor-generator outfit, where the motor is to run on direct current, and the generator is to produce alternating current, is illustrated in Fig. 7. A is the motor commutator, to which are connected the coils of the armature (not shown). B denotes the collector rings of the generator, to which are connected its armature windings (not shown); F and W indicate the field windings of the motor and generator respectively; R and S are variable field resistances connected in series with the motor and generator fields, and are used to regulate the speed of the motor and the electromotive force produced by the generator. Increasing the resistance in series with the motor field causes the motor to speed up. Increasing the resistance in series with the generator field lowers the electromotive force. In like manner, decreasing the resistances causes an opposite effect in both cases. AM is an ammeter, connected in series with the alternating-current line, while VM is a voltmeter, shunted across the alternating-current line. Further explanation of this diagram is unnecessary, as the connections are self-explanatory.

Reversing D.C. Shunt-Wound Motors

It is sometimes convenient to be able to reverse a direct-current motor, without undue loss of time, or inconvenience. In arranging apparatus for this purpose, it should be borne in mind that the motor will be reversed if the direction of the flow of current is changed in either the field or the armature; but if the direction of flow is changed in both the field and armature, the direction of rotation will not be altered.

In Fig. 8 is illustrated a type of reversing switch in common use. It consists simply of two metallic blades AB, pivoted at PR, and fastened to handle H, constructed of some insulating material and by means of which the blades may be moved to the position indicated by the dotted lines.

A type of reversing switch most generally used is shown in Fig. 9. This is readily constructed by making the proper connections on any ordinary double-throw switch, designed to carry the amperage necessary to operate the motor. These connections are also quite simple.

Figure 10 illustrates the method of connecting a reversing switch in series with the armature. SB is the

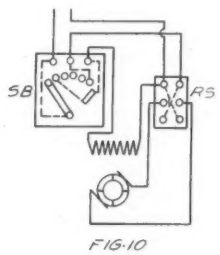


FIG. 10

FIG. 11

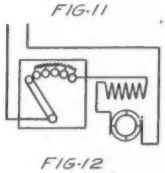


FIG. 12

FIG. 10. REVERSING SWITCH USED IN ARMATURE CIRCUIT

FIG. 11. TYPICAL RHEOSTAT USED IN CONNECTION WITH SERIES MOTORS

FIG. 12. DIAGRAM OF CONNECTIONS OF RHEOSTAT SHOWN IN FIG. 11

starting-box; RS is the reversing switch. These connections are shown clearly in the diagram, and should cause no difficulty in following out.

Care should be exerted in operating this reversing switch, and in all cases the motor should stop before the current is reversed.

Series-Wound Motor-Starting Resistances

A simple form of rheostat used in connection with series motors is shown in Fig. 11. The resistance wire is embedded in the back of the iron plate, but insulated from it, while ribs on the front offer an increased cooling surface. As this wire will carry the current for a short time only, and will heat considerably while starting the motor, the handle should never be left on any of the intermediate starting points; a coiled spring in the hub of the handle prevents any such carelessness. On the last point a clip holds the arm in place, the last point being so connected as to omit the entire resistance. Figure 12 shows clearly the method of connecting up this type of rheostat.

Figure 13 shows the connections for an automatic release starting rheostat. As the field of a series-wound motor is in series with the armature, it offers resistance to current at starting. The series motor, therefore, does not require so large a starting resistance as the shunt motor.

In Fig. 14 are shown the connections where a reversing switch is used. FG are fuses; M is the main switch; SB is the starting-box; RS is the reversing switch. As is the case with the shunt-wound motor, the reversing

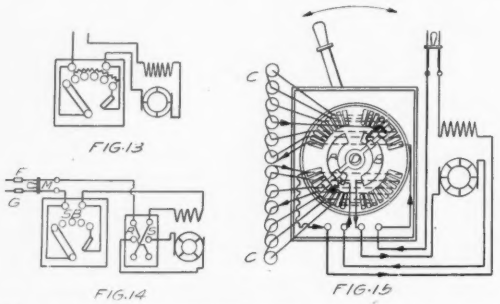


FIG. 13. DIAGRAM OF CONNECTIONS OF AUTOMATIC RELEASE STARTING RHEOSTAT

FIG. 14. REVERSING SWITCH USED IN CONNECTION WITH AUTOMATIC-RELEASE STARTING RHEOSTAT

FIG. 15. HEAVY-DUTY MOTOR CONTROLLER CONNECTIONS

switch should not be thrown until the motor has stopped.

Figure 15 illustrates the connections for a controller manufactured by the Electric Controller and Supply Co. used in a large number of mills and plants for operating cranes and other heavy-duty machines. The left-hand contacts are connected to the resistance coils, C, and also to the right-hand contacts. The brushes which

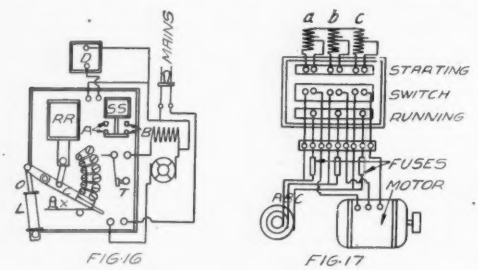


FIG. 16. DIAGRAM OF CONNECTIONS OF REMOTELY CONTROLLED STARTING BOX

FIG. 17. DIAGRAM OF CONNECTIONS OF TYPICAL 3-PHASE MOTOR STARTING COMPENSATOR

bear on the contacts, as well as the brushes bearing on the strips, A and B, are insulated from the arm, D. The arrows show the path of the current.

Automatic Starting Rheostats

It is frequently convenient to be able to start a motor from some distant point. This convenience is provided for by means of automatic starting rheostats. One type, manufactured by the Cutler-Hammer Co. is illustrated in Fig. 16. The controlling switch, at a distant point, is shown at D. When this switch is closed, the solenoid switch SS is energized and raises its core, bringing together the contacts A and B. This action, which is made slowly and smoothly, due to the oil dash-pot, OL, closes the main circuit and energizes solenoid RR, causing its core to rise and move the contact arm C, over the contacts. After contact-arm C, has moved a small distance, the contacts at X are separated, placing a lamp in series with the solenoid switch, SS. When the arm reaches the last contact, it separates carbon contacts, T, thus placing a lamp in series with the solenoid, RR. A small current is sufficient to hold either solenoid core in place, so the lamps effect a saving in current.

Hints on Care and Operation of Starting Rheostats

Dirt and grease are quite often allowed to collect on starting-box contacts. This results in burned contacts due to the formation of arcs. The contact lever will stick and not respond properly to the spring in its hub. Occasionally a fuse is blown, due to the increased resistance caused by the dirt.

It follows therefore that the contacts should be kept clean and bright. With the main switch open, the lever of the starting-box may be moved over the contacts without starting the motor. Move the lever to the right, and then release it. If it flies back quickly and easily, the contacts may be assumed to be fairly clean.

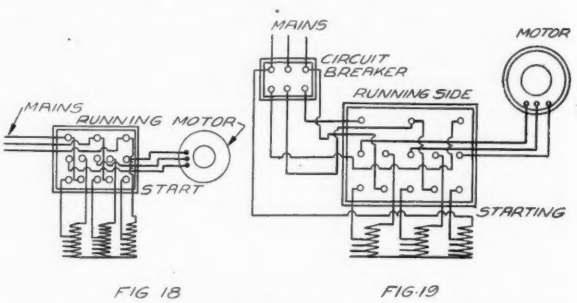


FIG. 18. DIAGRAM OF CONNECTIONS OF GENERAL ELECTRIC MOTOR STARTING COMPENSATOR

FIG. 19. CIRCUIT BREAKER INSERTED IN COMPENSATOR CIRCUIT

A rubber bumper is usually provided for the contact-lever to strike against when released. Levers will frequently rebound from this bumper and then stick on the first contact. This might be undesirable if the current should return to the line, with no one watching the motor, and as a result the motor would start and run slowly, until the resistance in the starting-box had heated sufficiently to melt and open the circuit. It is best to make sure that the spring is strong enough to move the lever off the first two or three contacts. It is good practice, however, always to open the main switch when stopping the motor.

When starting a motor it is preferable to move the contact lever quickly from one contact to the next, allowing it to remain a short interval on each contact. The quick motion from one contact to the next, tends to prevent the formation of an arc between the lever and contacts. A slow uniform motion throughout the entire throw of the contact lever, with perhaps a haphazard pause here and there, is unsatisfactory, as arcing results.

Alternating-Current Compensators

In starting alternating-current motors, the voltage applied to the primary is reduced by inserting in the circuits, variable resistances, or using auto-transformers. If the motor has a squirrel cage winding, a compensator is used.

Figure 17 illustrates the connections for a Stanley 3-phase starting compensator. Generator mains A, B, C are connected to the auto-transformers a, b, c, through the double-throw switch. The motor is connected to the variable taps 1, 2, 3, 4, etc. Thus with the switch at starting, the voltage is reduced. After the motor has come up to speed, the switch is thrown to the running position, short-circuiting the auto-transformers.

The connections for the General Electric compensator are shown in Fig. 18. Its operation is practically the same as that of the one just described.

As induction motors are apt to stop and heat excessively if overloaded, fuses and circuit-breakers are installed for protection. They are, however, likely to operate when starting the motor, even if starting conditions are all right, because when starting, an excessive current is used for a brief interval. They may, nevertheless, be connected so that they are not in circuit, until after the motor is up to speed.

Figure 17 illustrates the method of connecting the fuses for this purpose; a circuit-breaker may be connected as shown in Fig. 19. This breaker opens all 3 lines, but will not operate until the compensator switch has been placed in the running position.

The compensator method of starting permits the use of squirrel-cage windings, which are easy to construct and not likely to get out of order. If, however, a strong starting torque is desired, it is preferable to use a resistance in series with the armature.

The Manufacture of Armature Coils

Descriptions of the Various Methods Employed and Their Advantages and Disadvantages. By D. W. Perry

THERE ARE three general methods of making armature coils for commercial use, namely, on a mold, on a former or on a puller. The term "mold coils" is commonly used to include coils made over a form which can be rotated on a lathe, but turning only about ¼ of a revolution at a time, all necessary shaping being done with little pounding of the conductors. The term "formed coils" is usually meant to include those coils made over a stationary form, all necessary bends being made by the use of levers and mallets and, in general, considerable force must be applied to make the coils take the required shape. The term "pulled coils" includes those coils which are first wound on a shuttle fastened to a lathe, and then pulled on a coil puller to the shape required for winding into the slots.

The general method of designing coils is the same for any type. However, on account of the fact that a more accurate coil can be made on a former than on a puller, the formed coil is laid out with the intention of having all parts of the coil wind the same; that is, to have the top side of the coil wind as tight as the bottom side. This is impossible with a pulled coil. The top side, or side away from the air-gap, always winds looser than the bottom side, or the side nearest the air-gap.

Molded or Formed Coils

Molds are made of wood and fiber. These materials are cheap and are easily worked into the right shape and the fiber is tough enough to stand the wear at the bends. The frame or body of the mold is made of wood. The wire space, or the grooves into which the coil is wound, is cut into the wood or, as is the case at bends, it is built up of fiber plates or strips. This wire space is made so that the coil wound in it will have the correct shape. The molds when in use are bolted onto the face plate of a lathe so that they can be rotated, thus winding up the coil. Those for one-coil-per-slot windings, for concentric windings and for diamond-type coils wound with a loose formation (so-called "basket coils") are made so that the coil can be wound up without cutting the wire, the wire space on these molds being made of such a size as to give the finished coil a dimension that will permit its being wound readily into the slot.

The molds for diamond-type coils, where a certain definite formation of the conductors in the slots is required, are made different from the above type of molds. In the latter case the coils are wound in layers and turns. If the wire space were made the size of the finished coil it would be a difficult operation to keep each wire in its proper place while winding the coil, as the bends place the strain first on one side of the wire space and then on the other. To avoid this the molds are made for only one wire in width at a time, and the coil is then wound up into sections, each having the same number of turns. The wire is cut after each section is wound and tied; the mold is opened and the section is removed, the molds being made so that the sections can be removed without distorting them. After winding the required number of sections these are assembled and connected to form a complete coil.

Round wire is the only shape that can be used under all conditions on a mold with any degree of safety. The sharp bends that are made cause square wire or ribbon to turn up on edge and the insulation on the wire is cut through, causing a short-circuit in the coil.

The chief disadvantage in connection with the use of molds is the space required for storage. A new mold has to be made for each new coil, and these molds must be kept to supply repair coils. This means that storage must be found for all these molds. It therefore soon becomes a great problem to find room for the vast number of molds that are the result of an ever-increasing demand for new motors, each requiring some slightly different coil.

Formers have to be made much stronger than molds as a rule, because the coils are pounded to shape on them. For heavy strap where great force is required the formers are made of iron, which increases their cost materially. In order to avoid this expense, where possible, wooden formers are used which are strengthened at the bends with pieces of iron.

The strap or ribbon to be wound on the former is cut to the required length and then bent around a pin the size of which is governed by the size of the copper and also the voltage. In most cases this is the only bend that is made in the copper before being placed on the formers. However, in some cases where heavy strap is used and the bends are comparatively sharp, the strap is bent to the general shape before being placed on the former, and then by means of levers and a mallet the strap is forced to take the shape of the former.

Very accurate coils can be made on the former. In the first place the coils have been laid out on a drawing board, and in this way the dimensions are obtained for the best coil for the conditions. With a former made to these dimensions, all coils in the set will be correct if a reasonable amount of care is taken in forming them.

A formed coil has the advantage of having a short coil extension because of the fact that all parts of the coil are formed so as to use the minimum length of copper. By coil extension is meant the distance between the ends of the coils and the core. As the overall dimensions of the machine are materially affected by this extension, it is sometimes worth the difference in expense to use a formed coil, when another type of coil would otherwise have met the requirements.

Pulled Coils

The first operation in making pulled coils is the winding of the coils on the shuttle. This is made of wood and fiber. The center block around which the coil is to be wound is made the length of the straight coil. The width is determined by the diameter of the fiber pins at each end. The diameter of these pins depends upon the voltage, the size of the conductor, and upon general conditions encountered in winding. The thickness of the center block depends upon the width of the coil.

The sides of the shuttle are cut longer and wider than the center block, so that when assembled it leaves a slot into which the coil may be wound. The center block is fastened on one of the wooden side pieces, which is secured to the lathe. The other side is secured by the fiber pins at the end of the center block and by a steel pin on the face plate which extends out through the removable side. This center pin has a slot into which a wedge-shaped key is driven, holding the side up tight. These shuttles are cheap as compared with the cost of a mold or a former and can easily be adjusted for a new coil by adding a new center block and, because they are cheap and can be used on different jobs, it is not necessary to store them after the coils are wound, except for standard sizes.

The use of the shuttle and puller eliminates most of the soldered joints that are made on mold coils. Since the coil is wound on the straight shuttle and pulled afterwards, the coil can be wound hit or miss, or in layers and turns, without cutting the wire.

The puller gets its name from the operation which it performs. It is a machine so designed that the coils taken from the shuttle can be pulled to the required shape. The straight parts of the coil are pulled to the required angle of throw, and at the same time are given the correct bevel for winding into the slot. The diamond ends of the coil are kicked up to the required height to give the correct winding angle. A skilled operator can pull a small coil in 2 min. or less. About the same time is required to tie the leads. The actual time required to wind the coil on the shuttle and then pull it is much less than that required to wind the same coil on a mold. Take for example a coil of 4 by 5 wires per coil, 4 by 1 in parallel. This means that the coil is 4 wires wide by 5 wires deep, and there are 4 wires per coil in parallel, or, in other words, that it is a 5-turn coil. On a mold this coil would be wound in 4 sections of 1 by 5 wires per section. The time required for winding one of these sections is about 5 min., making a total of 20 min. for winding the complete coil, since there are 4 sections per coil. The time required for assembling and tying these sections is 7 min., giving a total of 27 min. for winding the complete coil. With a puller, the coil will be wound on a shuttle with 5 turns of 4 wires, 5 min. being required for this operation. The coil is then pulled and the leads tied in 3 min. This makes a total of 8 min. for the pulled coil against the 27 min. required for the same coil on a mold.

The pulling machine is also adjustable for various sizes of coils. By simply loosening a few nuts and making a few adjustments, the machine is ready for another job. No time is rquired for making a new tool and no space is required for storing the tool used on the last job. Within certain limits, fixed only by the size of the puller itself, its application is unlimited.—The Electric Journal.

Foreign Development in the Power Plant Field

Utilizing Surplus Electrical Energy Under Boiler. By J. H. Blakey

At the hydro-electric plant for the distribution of current at Zurich, Switzerland, there is at certain times of the year an excess of energy, but, until recently, there has been no means of using it. The suggestion was made to use this surplus to keep under pressure boilers in the station which are used for steam heating and to supply steam for small engines around the plant. Experiments were made with 2 boilers and the results were so promising that the company gave an order for electrical heating apparatus which could be placed on the grates of the 3 boilers in the station, which are of the ordinary water-tube type. These appliances have been in use since September, 1915, and are giving perfect satisfaction. The apparatus consists of a frame on which are placed the resistance elements, which are of cast iron, with insulation of mica. Each heating unit consists of 6 sets of resistances grouped 2 and 2 in series and connected in pairs to the terminals.

By means of switches on the outside of the furnace the resistances can be grouped differently in case of necessity, to suit the varying intensity of the current, or they can be arranged to use either alternating or direct current.

During the electrical heating of the boilers both ends of the furnace must be kept hermetically sealed. The maximum temperature of the resistances is about 1100 deg. F. The 3 boilers equipped with the electrical heating appliances furnish a total of 12,500 lb. of steam a day with a consumption of 7392 kw.-hr., which is about 0.6 kw.-hr. per pound of steam; thus saving about 1650 lb. of coal a day. Of course, there is no expectation of getting high pressures by this method; nevertheless, that considerable pressures can be obtained is shown by the fact that over 100 lb. absolute was reached after 100 hr. of heating during the experiments.

Reinforced Concrete Investigations

In a recent number of the Schweizerisch Bauzeitung, M. Zschocke gives the results of investigations made upon reinforced concrete at the Swiss Laboratory for testing materials of construction, both in the laboratory and as a part of buildings already constructed. As the result of these experiments the author recommends: 1. The use of cement as rich as possible in free lime, so that the acids which attack iron may be neutralized. 2. The covering of the iron with a coating of pure cement. 3. To avoid the use of sand or gravel containing matter capable of neutralizing the lime in the cement. 4. To avoid by all means possible the cracking of the concrete.

Of a number of test pieces prepared 5 yr. ago by coating with minium* paint, tarring with coal tar or asphalt, galvanizing and covering with a mineral coating such as pure cement, and exposed during that time to the action of the weather, only those specimens coated with minium paint were found to be perfect.

The author observed also that the iron in concrete structures located near manufacturing plants was more seriously attacked by rust than that in buildings in other situations, such as railroad bridges at a distance from centers of population. This is accounted for by the fact that the air in manufacturing districts contains impurities in the form of acids, which reach the iron through the porous concrete. The examination of the metal in completed structures was made by means of X-ray photographs.

Bursting Elbow Causes Fatality

By E. C. Smith

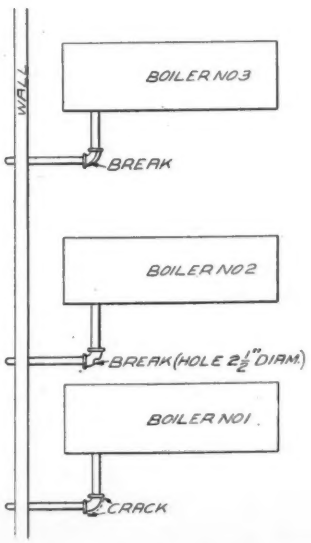
On Tuesday, Feb. 6, 1917, shortly after the noon hour, the elbow on the blowoff pipe to boiler No. 3, at the Burdick Hotel, Kalamazoo, Mich., burst under a pressure of about 55 lb., scalding the engineer in charge so severely that he died the following morning. Two others, the fireman and a plumber, were slightly scalded, but will recover. The minutest details of this accident will perhaps never be known; as is often the case, the man who might have thrown some light on the matter did not live to tell.

*Note.—Minium is a red oxide of lead (Pb_3O_4) prepared by the further oxidation in an oven of lead monoxide.

These boilers (3 in number) were installed in 1911. They were of the return tubular type, 60 in. in diameter, 14 ft. long, butt joint, double strap, constructed for high pressure work. The blow-off was 4 in. in diameter to the outside of wall, where it was reduced to 2 in. The leg from the boiler to el is about 3 ft. long, and the horizontal pipe is about 5 ft. long. The blowoff valve is a 2-in. asbestos packed cock. Standard fittings were used throughout.

One phase of the situation which is hard to solve is the fact that the similarly located elbows on the blowoff pipes to all boilers ruptured within 48 hr.

No. 1 boiler had been in service for several weeks and on Sunday morning, Feb. 4, it was discovered that the tubes were leaking very badly, so No. 2 was fired and cut in, and No. 1 allowed to cool for repairs. At about noon of this same day the el on the blowoff to No. 2 let go, blowing a round hole about 2½ in. in diameter out of the bottom side of the el.



BLOWOFF PIPING WHICH CAUSED ACCIDENT

The unfortunate engineer was at home sick and had not been on the job for about 6 weeks. It was known that there was a bad water hammer in the feed line to No. 3 boiler. Competent help was called in and the repairs on No. 1 completed, and it was tested with water pressure, after which it was fired and put into commission. On Monday the engineer returned to work. No. 3 was opened and examined, the feed line repaired, after which it was fired and put into commission.

The change was made at about 3 a.m. Tuesday. After No. 1 had been cut out for a short time it was discovered that it was losing water. Upon examination it was found that the elbow on the blowoff pipe was cracked down the center on the front side, but did not separate entirely. A little after noon of the same day it was noticed that the water in No. 3 was above the customary water line. The engineer requested the fireman to blow it down a little. The fireman tried, but reported that it did not operate as it should, whereupon the engineer went around back of the boiler to operate

the valve, and at this moment the el on the blowoff pipe burst, the front half of the el separating entirely from the balance of the fitting. It is claimed by those who were present that the engineer did not have time to open the valve. The valve was found closed.

In conclusion, we wish to state that the fire box and combustion chamber under these boilers are of an unusual type. Unfortunately the writer does not know the name of the furnace.

An unusually large number of fire brick were used in the construction. Baffle walls, arches, and a large combustion chamber were the principal features, the object being to retain all of the heat possible. We were told that the architect received his inspiration from furnaces of a like description which he had seen in Chicago.

(The surprise is that the elbows held as long as they did. These fittings should be extra heavy and the reduction of a blowoff pipe is a practice most severely condemned.—Editor.)

Developing a Community's Industries

SOCIETY FOR THE ESTABLISHING OF USEFUL MANUFACTURES HAS PUT PATERSON IN THE FOREFRONT OF SILK MANUFACTURING INDUSTRIES

STIMULATION of manufacturing projects was the object of the Society for the Establishing of Useful Manufactures which was organized in New Jersey in 1791. Among the first activities of the Society was the purchase of 700 acres of land near Passaic Falls, upon which it built a cotton mill and laid out streets for a new town, which was called Paterson after the then governor of New Jersey. Later, the Society commenced

FIG. 1. VIEW OF PASSAIC FALLS

the construction of raceways in the Passaic River, for the purpose of generating power from the Falls, with water wheels having a total rated capacity of 2270 hp., and water rights were sold to those agreeing to erect mills on the Society's property. In this way many were induced to build. For some time the manufacture of cotton cloth was the principal industry. This was followed by the erection of a steel mill, and later by the manufacture of silk cloth, for which Paterson is now justly famous. At a still later period the Society bought some of the mills that had been built and regained some of the water rights that had been sold in the early years of its existence.

As, however, under the original development only a small part of the water available during the rainy season could be utilized, and it was impossible to furnish sufficient power during the dry seasons to operate the mills which were built, a new project was decided upon. In 1911, therefore, the Society commenced clearing the river bed below the Falls, making a channel 125 ft. wide for several thousand feet downstream. Early in 1912, the work of constructing a hydroelectric plant was started, and of an auxiliary steam plant in 1914. Owing to the peculiar nature of the ground the hydroelectric plant was built against a trap rock bluff with its foundation in the basin below the Falls, while the steam plant was erected 200 ft. to the East and located on solid rock.

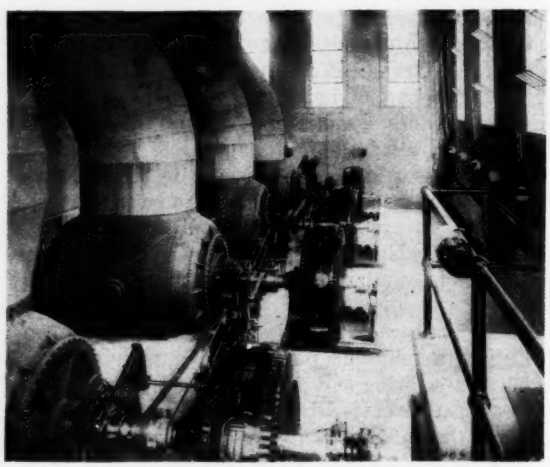


FIG. 2. HYDRAULIC UNITS AT PASSAIC FALLS

The hydroelectric plant is 105 ft. long and 40 ft. wide. It is a substantial building with solid concrete foundations made water tight for 10 ft. above the floor on which the generators are installed, and above this the walls are of white brick with terra cotta trimmings. The building has a steel truss roof covered with concrete, on which is laid ornamental green tile. A tower is built at one end containing an elevator shaft and a stairway leading from a balcony, on which the switchboard is placed, to head gates and forebay above.

The waterwheel equipment of the hydroelectric plant consists of 2 exciter units of 100 hp. each, driven independently and connected to 125-v. generators operating at 700 r.p.m. Each unit is of sufficient capacity to furnish excitation for the 4 generators with which the plant is equipped, when all are under full load. The first main waterwheel is operated at 514 r.p.m. and is connected to an 850 kv.a. 60-cycle, 2400-v. generator guaranteed to carry a 25 per cent overload continuously. The remaining 3 units operate at 450 r.p.m. and are each of 1250 kv.a. capacity. The water wheels are of S. Morgan Smith manufacture with Lombard governors, and the electrical equipment, including a switchboard, was manufactured by the Westinghouse Electric & Mfg. Co.

The steam plant is of the same general design as the hydroelectric plant, but is a much larger building. The boiler room is faced inside with salt glazed brick with white trimmings. A stack of radial red brick 10 ft. in diameter rises 175 ft. above the boiler room floor. When fully equipped, this building will contain 7 boilers of 516 hp. each, and will have a generating capacity of 8500 kw. At the present time, the equipment consists of 3 Edge Moor boilers of 516 hp. each, having 20-ft. tubes with 4 passes. The boilers have steam soot blowers built in the setting and are served by Westinghouse underfeed stokers driven by a Westinghouse engine. Forced draft is supplied either by a marine type turbo blower or by a Westinghouse horizontal turbine connected through reduction gearing to a double inlet radial flow blower.

Steam is generated under 175 lb. pressure and 100 deg. superheat. There are 2 12-in. steam headers in the boiler room, one for high pressure the other for an 80-lb. mill supply line, which furnishes steam to 6 mills and

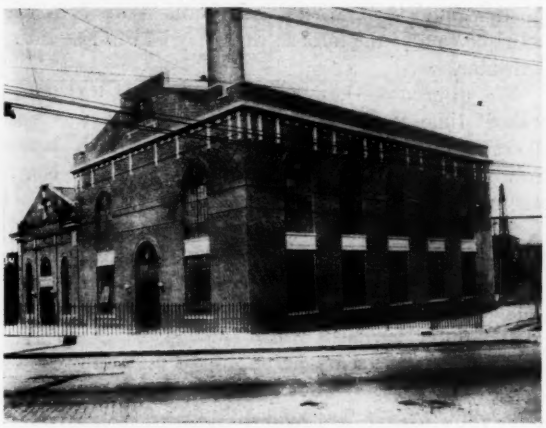


FIG. 3. STEAM PLANT BUILT AND MAINTAINED BY THE SOCIETY

a dye shop. Nearly all of the condensed steam used in the mills for heating purposes is returned by steam traps to a tank placed above the heater and then flows by gravity into the heater.

Cream face brick is used for the finish in the turbine room which has a balcony at the end at the same elevation as the boiler room floor. On this balcony there is a switchboard fully enclosed in glass. The bus bars, oil switches and some of the disconnecting switches are directly underneath the switchboard. The remainder of the disconnecting switches, and current and potential transformers are supported underneath the oil switches. The generating equipment includes a 1000-kw. maximum rated Westinghouse single flow, high-pressure, condensing turbine of the combination type having an impulse element followed by reaction blading. This turbine is direct connected to a 1250-kv.a., 3-phase, 60-cycle, 2400-v., 80 per cent power factor Westinghouse generator, and is served by an 1800-sq. ft. surface type Westinghouse-Leblanc condenser located immediately underneath the turbine. As the cooling water is delivered by gravity from the forebay through a 36-in. cast-iron pipe to the condenser under a 30-ft. head, no circulating pump is required. Air and condensate pumps are installed, however, mounted on the same shaft and direct connected to a Westinghouse impulse turbine. The exciter equipment includes a 50-kw. Westinghouse turbine driven set.

Steam is delivered to the turbines from the boiler room down through openings back of a dividing wall and under the turbine room floor, so that the only pipes in view from this floor are those that come up through the floor to the turbines. A connection is made with the exciter bus in the hydroelectric plant through a double throw switch to either of 2 direct-current busses in the steam plant. By this method, direct current is always available for solenoid operated switches as well as for excitation, if required. All of the current generated in the hydroelectric plant is delivered to the steam plant bus through 2 sets of 1,500,000 c.m. cables and distributed from there, leaving the steam plant underground.

Change of Design Recommended to Prevent Pitting of Water Turbines

SPEAKING before the Western Society of Engineers at a recent meeting, Prof. S. J. Zowski, of the University of Michigan, stated that the pitting of water turbine blades could be reduced materially by improving the design of the guide vanes and buckets.

Due to the fact that a slight vacuum is created at various points by a sudden bend or expansion in the jet, the water tends to deaërate and as a result of the electrolytic action which is established between the oxygen of the liberated air and the metal, corrosion and pitting occur at these contact points.

It was recommended that the parallelity of the epicycloidal bucket lines be abandoned in water turbine design, in order that the water may easily follow the slope of the buckets at all points and prevent the formation of air pockets.

Business Philosophy

PAINSTAKING care in little things is a part of genius; painstaking care in little things insures perfect work; perfect work will bring you trade; trade well managed will make you rich; riches well spent will bring you happiness; supreme happiness is sure to be found in living. when the purpose is to make the people who come within the sphere of your influence happier and better.—J. W FISHER.

SOCIETY FOR ELECTRICAL DEVELOPMENT announces a cash prize campaign for a "Wire Your-Home" contest to be held from April 1 to May 15, to which all salesmen are eligible. Cities are divided into 5 classes, the first for population of 15,000 or under; the second, from 15,000 to 50,000; the third, 50,000 to 100,000; the fourth, 100,000 to 500,000; the fifth, 500,000 and over. In each class there will be a first prize of $150 for the man who can show the largest number of contracts secured between April 1 and May 15; a second prize of $50 in each class, and 5 prizes of $10 each in each class. Full information can be obtained from the Society's office, 29 West 39th St., New York City.

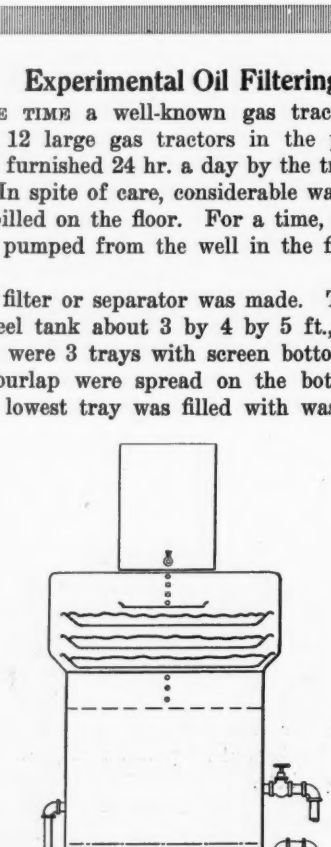
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Experimental Oil Filtering

AT ONE TIME a well-known gas tractor company ran 10 to 12 large gas tractors in the power house. Power was furnished 24 hr. a day by the tractors under belt test. In spite of care, considerable water, fuel and oil were spilled on the floor. For a time, this accumulation was pumped from the well in the floor drain to the sewer.

Then a filter or separator was made. The base was a heavy steel tank about 3 by 4 by 5 ft., set on end. Above this were 3 trays with screen bottoms. Several layers of burlap were spread on the bottom of each tray. The lowest tray was filled with waste, the next



OIL FILTER MADE FOR EXPERIMENTAL PURPOSES

one with sawdust and the top one with shavings and excelsior. A 20-gal. tank was set on a platform above the trays. This platform was supported by steel pieces, bent around the trays and resting on the head of the tank. Oil dropped from a drip cock in this tank onto a pan with perforated bottom which distributed it over the first trays. A flush valve, an oil valve and a glass gage were arranged on the tank.

Practically all the water separated in the well and was pumped directly to the sewer. The remaining oil, fuel, water and dirt were put in the 20-gal. can and run through the filter slowly. Some water separated in the steel tank. To drain this water without trouble a ¼-in. pipe was tapped into the bottom of the tank and run up about 2 ft. The oil was drawn off well above the dividing line so as to keep about 2 ft. of water in the bottom of the tank.

The filter was easily cleaned by lifting out the trays and dumping them. Most of the dirt was caught in the first tray. The waste and burlap were squeezed dry and washed in gasoline.

Probably the results would have been better if the trays had been smaller, deeper and more numerous. Also the drippings from the trays should have been piped to the bottom of the tank so that they had to rise through the water.

The filtered oil, however, was clean. It was used for a short time to lubricate the engines. It was not at all satisfactory because there was so much kerosene and distillate in it. The engines heated and the bearings ran warm.

Then the filtered mixture was dumped into the fuel tanks of the engines. None of it seemed to burn. At least, the stuff accumulated rapidly. It was finally disposed of by pumping it into the supply tanks of the steel foundry furnaces which burned crude oil.

This filter is no longer used. I understand that the drippings are now strained into the furnace tanks; however, the filter was a cheap and satisfactory way of finding that the power house drippings had not enough lubricating value to make their use as a lubricant worth while.

C. V. HULL.

Metallic Packing for Water Ends of Pumps

IF ANY of the readers have had experience in the use of metallic packing for rods on water ends, it would be useful to know of the results. We made a trial of a test sample on a Blake 7 by 10 by 12 pump taking water from an open heater, at temperatures ranging from 95 deg. F. at night when there was practically no exhaust steam to 210 deg. F. in the day when the engine was running.

This pump was 2 yr. old with long stuffing boxes so that there was no trouble in keeping the rods packed with fibrous packing, renewing it every 5 or 6 hr. But we got the fever for metallic packing, and the agent was given permission to make a trial.

The packing was in pebble form of a rather hard anti-friction metal coated with graphite and beeswax, which formed a compact mass when tightened in the stuffing box. The coating gradually worked out, but the hardness of the metal prevented it from forming a solid ring around the rod.

When the pump was put into service after inserting this packing, the water was at 210 deg. and only an occa-

sional drop of water oozed out until the packing warmed up, when there was quite a leakage; but tightening the gland stopped this.

When the agent returned next day, however, he did not get the most cordial reception, for after the engine was shut down and the temperature of feed dropped, the packing contracted and developed a bad leak which could not be stopped by tightening the gland as much as possible with a 12-in. wrench on ½-in. nuts.

We kept at it for a week, but with unfavorable results whenever the feed water was cool. Then we went back to fibrous packing.

Spite of this experience, I believe that metallic packing of proper form and hardness would work all right; but the metal must be soft enough to compress into a solid ring. Even then, where there are widely varying temperatures, it is a question whether the ring could take care of the expansion and contraction.

Some time ago we had a shredded metallic ring packing on the stems of the steam valves of a Greene engine and could not stop leakage without getting so much friction that the valves would stick open against the action of the solid weight dashpots.

I would be pleased to know if other readers have been able to secure satisfactory results under like conditions. R. A. C.

To get further data on this subject, the experience above was submitted to two makers of metallic packing, and the substance of their replies follows:

"We do not recommend our Safety Plastic Metallic Packing for rods that are worn tapering, that vibrate, or that travel out of line. Nor do we recommend this packing for rods that have considerable expansion and contraction, caused by sudden and extreme changes of temperature, as was the case on the pump described.

"This packing forms itself to fit the rod perfectly by pressure of the gland, and like other metallic packings, it cannot give and take to the inequalities of an expanding and contracting rod. When this packing is properly applied to machinery that is in suitable condition, it is practically impossible for it to fail. It is being used in many plants on the water end of boiler feed pumps, as well as many other classes of hydraulic pumps, on both hot and cold water; but, as before said, it should not be used on rods that have extreme changes of temperature on account of the expansion and contraction of the rod." STEEL MILL PACKING CO.

"We should judge that this engineer's theory as to the cause of the failure of the packing is an excellent one, and it is quite possible that this particular style of packing which was used by him was not suited to that particular condition.

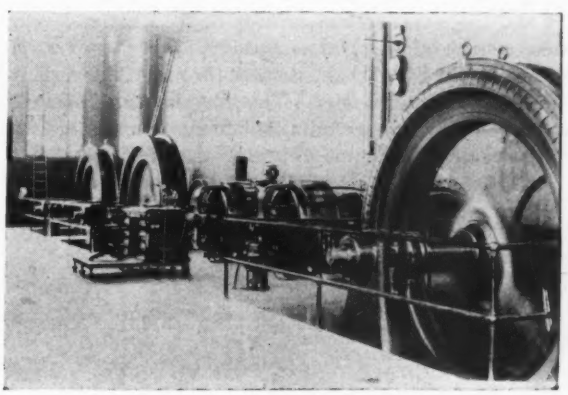
"For our own part, we do not believe, *but know positively,* that boiler feed pumps can be packed with metallic packing, and this metallic packing will take care of the changes in temperature just as great as those stated in the letter of your correspondent.

"Our packing is made of a very soft, anti-friction metal, which is twisted together with strands of cotton. The inner core of the packing is composed of these strands of metal and cotton combined, and the core is covered with braided strands of the same material. The finished packing is so flexible, and allows of so much compression, that it will always hold the rod tight, particularly when the pump is running, as the cotton in the packing will expand gradually under the action of the water. The packing is so constructed that there is always a bearing surface of metal next to the rod, and this metal not only acts as a strong binder for the packing and gives it body, but at the same time it acts as a preservative of the rod."

FEDERAL METALLIC PACKING CO.

Advantages of Symmetrical Water Power Layouts

DESIGNERS of steam plants generally recognize the value of a symmetrical layout from the operating standpoint, and in the newer hydroelectric stations one finds similar appreciation in most cases of the benefits of a clear-cut and logical arrangement of equipment. There are still many water-power plants in service, however, to say nothing of steam stations, where a jumbled assortment of apparatus is producing energy under the handicap of poor arrangement. The reader can picture for himself a representative plant of the older type, where line shafts and belt drives may still be doing duty because the supply of water is adequate during a portion of the year if not at others; where odd sizes of units and cramped quarters make operating a particularly cautious task, and where it takes a new man a considerable time to "learn the ropes of the station."



CONVENIENT ARRANGEMENT OF HYDRO ELECTRIC MACHINERY

Very likely in many cases it will not pay to attempt to revamp the design; but, by contrast, attention is called to the accompanying illustration of a small hydroelectric plant forming one of a group of stations on a Maine system, where the principle of symmetry is unusually well followed. In this case the exciters are direct driven by individual water wheels, each fed by a separate penstock, and the exciters are located in the center of the operating bay with the main units on either side. Each of the latter follows the modern direct-connected practice, as a matter of course. In this station the switchboard stands on the floor at the left of the main units, not visible in the illustration. The power house wall was built almost into the dam in this case, local topographic conditions permitting this, and the penstock length is short, the direct run of pipe from the forebay to each unit eliminating

any complications of branched feeds, multiplied valves and gates, or extensive surge chambers associated with long and high-head flumes.

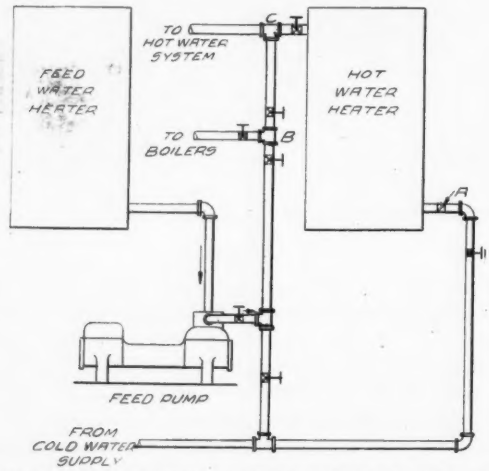
The transformation of energy from the water flow through the penstocks to electricity in this case involves merely a straightforward progression. The generators are connected with the switchboard by short cable runs below the floor; there are no complications in the wiring of these units to their respective controlling panels, and the exit of the outgoing lines through wall bushings behind the switchboard involves a minimum outlay in copper and a maximum of convenience.

Such a layout looks almost ridiculously simple from some points of view, and yet it is not always easy to obtain. Simplicity of arrangement in moderate sized stations, however, is well worth striving for, because it means realizing a given productive capacity for the least expenditure in material, if it is combined with symmetry. The case illustrated would not, of course, solve every small water-power problem of moderate or low-head service; but it may fairly be accredited a standard type worth studying in connection with the building of new installations or the rarer task of remodeling an existing ill-designed hydroelectric plant.

H. S. KNOWLTON.

Small Change in Piping Results in Large Saving

IN A COMBINED lighting, heating and pumping plant in which the heating system is of the vacuum-return type and the water system consists of both hot and cold water, considerable loss was occasioned by water at a temperature of 210 deg. F. passing through the overflow from the feed-water heater. This was due to a constant stream of cooling water admitted to the heating system return making a surplus of water in the heater.



SCHEME OF CONNECTIONS BY MEANS OF WHICH HOT WATER IS DELIVERED TO HEATING SYSTEM INSTEAD OF SEWERS

The heater had both automatic overflow and "make-up" valves; the boiler feed pump was regulated by hand.

The pressure in the water system was only a few pounds lower than the pressure carried in boilers.

To stop this unnecessary loss, the writer placed a check valve at A in the accompanying cut and a bypass with valve, from B to C. The automatic makeup valve was changed to the steam supply for boiler feed pump, so the speed of this pump was controlled by the height of water in the feed-water heater. This arrangement maintained a constant level in this heater and prevented the water reaching the overflow.

The height of water in the boilers was regulated by means of the valve in bypass B-C, thus allowing all surplus water to go to the hot-water supply system instead of the sewer. This scheme has been in operation now for some time and has resulted in quite a saving.

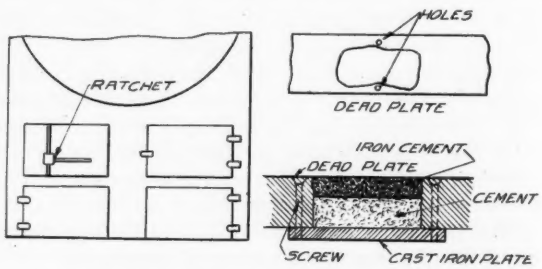
J. M. ROW.

Repairing Dead Plates

AT ONE time we had charge of a plant in which the normal load was more than the rated boiler capacity. When the heavy load came on every 2 hr., things were not improved.

It was found that much good coal was finding its way into the ash pit and considerable cold air was entering the furnaces to no advantage. As there was 7-day service no time was available in which to put in a new dead plate, so I decided to repair it this way.

When the fire was cleaned, it was banked against the bridge wall. A ratchet drill was employed to drill 2 clearance holes in tandem across the width of the dead



METHOD OF REPAIRING DEAD PLATES

plate, a piece of cast iron somewhat wider than the burned hole in the dead plate having been obtained, 2 holes were drilled and tapped in it and it was secured beneath the dead plate with countersunk head screws, as shown. About half the thickness of the dead plate was filled with cement, using the cast-iron piece as a bottom. The remainder of the thickness was filled with an iron cement recommended for repairs. This job ran 2 months when confidence was fully established in the method, and the other 7 boilers in the same condition were repaired. These lasted 6 months, until the annual shut-down, when new plates were put in, the old showing no signs of distress.

RECEIVER.

The Elements Don't Wear Out

I READ these words in Sparks from the Advertising Pages in the Jan. 15 issue with much interest:

"Everything under the sun wears out after a time. Nothing is permanent. Even the great pyramid of Cheops will some day be worn to the ground. Things that are material no sooner reach their finished state than they begin to deteriorate.

"Just a few things can be done to stave off the hand of Time. You have often observed property going to rack and ruin because of the lack of attention—the need of a coat or two of that preserving element, paint, for instance. And the cost to keep it in repairs is less than the cost of 'reclaiming' it after it has been allowed to totter and fall."

I hadn't thought of it in just that way before, and perhaps some readers haven't thought of it yet at all. If not, I would suggest that the SPARKS in that issue be searched for and read.

The first paragraph sort of knocks in the head the old adage "There is nothing new under the sun." The fact that things are constantly wearing out, leaves the world in a constantly changed condition, and therefore in a constantly *new* condition. Hence there is always something new under the sun.

In my way of looking at it, though, there *are* some things that don't wear out—water for instance. No matter how much you rub it, or shake it, it doesn't granulate like sand or rocks. Gases don't wear out. But, generally, those are the two things that work hand in hand in wearing out the other more stable things such as the pyramid of Cheops, boat bottoms, machinery, etc.

I get the idea of the writer of the SPARKS, however, and hope this additional comment will prove of interest.

N. G. NEAR.

Repairing an Air Pump

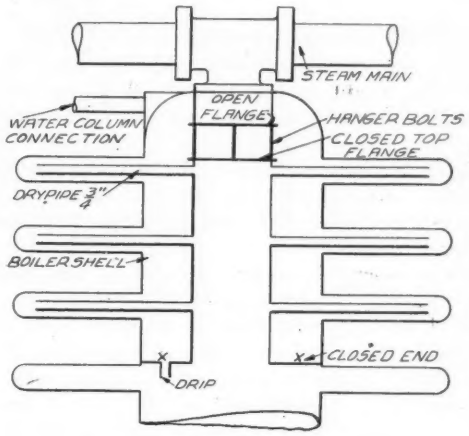
A JOB I just finished was trying to find why one of these pumps refused to work satisfactorily. It had not been in use for about a year and had been overhauled at a machine shop and put out by a so-called air compressor expert. The pump, however, did not deliver the goods; one of the remedies applied was inserting brass rings between valve cap and body of pump, the idea being to give the valve more lift. In the shop the projection on top of the air valve had been ground off to obtain a greater lift, but this failed to cure the trouble. A new pump had been bought and the chief and I put it up; we then concluded to take a hand at the old one. There is a slide valve in the top of these pumps having a vertical position and held true to port openings by a pin in casting. Instead of this pin filling in the groove of valve as it should, it was on one side of the valve. Here was the first trouble. There is in the cylinder a passage from strainer through casing to valve and into cylinder under the piston. This passage was completely stopped and so tight that about 2 hr. work was required to clean it out. Am sorry to say we found it full of fine particles of coal which had been deliberately fed through suction inlet after removing strainer. No new air valves were used in assembling the pump, and it is now doing good service.

A great mistake is using too much oil in the air cylinder of these pumps; this soon gets into the hose where air is used in hoisting ice and gums up. Then when steam is blown through the hose it loosens inner plies and the combination of oil, steam and rubber soon ruins the hose. We are now trying same oil as used in an automobile engine.

JAMES C. LEE.

Scale in Hazelton Boiler

IN A Hazelton boiler of the porcupine type, the superheater or dry pipe became stopped with scale. The water came from a pond which was muddy at times, causing scale to form in the tubes quickly and with no chance for a surface blowoff in this type of boiler, the scum floated into the superheater pipes (which are iron) and closed them up as a high water line was carried in the boiler.



SKETCH OF HAZELTON BOILER

It took some time to locate the cause, for it did not seem possible a pipe in the steam space of a boiler could clog up and it wasn't until a section of the lower flange was taken out that the cause was found. This allowed the superheater to be bypassed. There was no chance to see in or clean out the superheater pipes without taking the whole out, which would take too long and time was not available then.

D. F. C.

Repairing Small Leaks

NO DOUBT many of us are troubled with small leaks around rivets and in seams that keep up a corrosion of the plate and either can not be reached to calk or refuse to stay calked. I have overcome all such trouble by the use of the following:

Mix warmed common coal tar with enough Portland cement to make a sticky putty. The inside of the shell around the leak is thoroughly cleaned, washed with gasoline, and, if time is available, warmed with a blow torch. The warm putty is then applied, adhering closely to the metal. When pressure is raised, the tar cement is forced into the small leaks, and can sometimes be seen in the form of a bead on the outside, effectively stopping that annoying sizzling with its accompanying corrosion of the sheet. When the boiler is next opened, the surplus tar can easily be removed by simply cracking with a hammer, having hardened almost to stone. It costs little and does the work.

E. L. K.

U. S. CIVIL SERVICE COMMISSION announces the following examinations on March 6: Aeronautical Engineering Draftsman; $2000 a year; apply for Form 1312. Designing Mechanical Engineer; $2100 a year; applicants must have reached 30th birthday; Form 2118. Metallurgist; $2400-$3300; applicants must have reached 25th but not 45th birthday; Form 2118.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Construction of Sensitive Draft Gage

DESIRING a draft gage that did not contain any liquid, that would evaporate, or spill, the writer constructed a gage as shown by the accompanying drawings.

Figure 1 shows the gage with the dial removed, the movement being mounted in the case of an old steam gage. Figure 2 shows the front ofthe gage, with the dial in place.

The movement is suspended by steel wire hooks F, as shown, the moving element, H, resting on these hooks, H having knife edges, J, where it is in contact with the hooks; this practically eliminates all friction.

H can be made from a piece of a hack saw blade.

E is a hard wood cylinder about ⅜-in. in diameter,

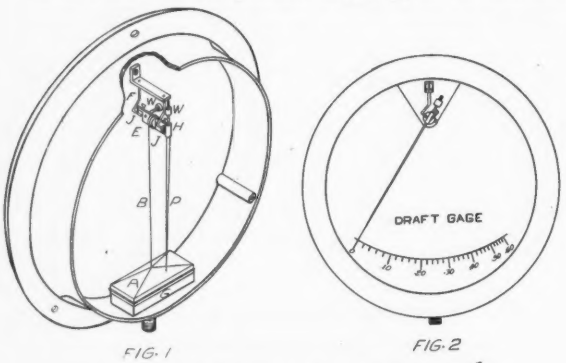


FIG. 1. MECHANISM OF DRAFT GAGE
FIG. 2. FACE OF DRAFT GAGE.

slotted and fitted over piece H, and having a groove for the silk cord, B, the end of this cord being fastened to the opposite side of the cylinder. The lower end of this cord is fastened to the center of the thin sheet rubber diaphragm, A, this diaphragm covering the metal box, G, as shown.

The diaphragm should have slack enough to allow about ½-in. movement of the cord, B, and should be fastened to the box, G, by wrapping with cord, and gluing or cementing, as it must be air tight.

The box, G, is soldered to the piece that formerly supported the gage spring, having a hole drilled in the bottom in communication with the pipe connection.

W, W, are counter weights for adjusting the pointer P.

To calibrate the gage, connect it to the boiler flue below the damper, connect a standard draft gage at the same place and regulate the damper to give the required draft.

The gage made by the writer gives a scale deflection of 1 3/16-in. on a draft of 0.10-in. water, and is connected to show furnace draft. R. L. MOSSMAN.

Cleaning Leather Belts

AT ONE TIME I worked in a power house where the belts gave a great deal of trouble on account of oil and grease. Power was furnished by 60-hp. gas tractors under test which were belted to 220-volt d.c. dynamos. Owing to the construction of the pulleys and also to the fact that the engines were changed frequently, the belts became greasy and dirty, for oil and grease worked out of the pulleys. The floor was also dirty from spattered and spilled oil.

A tank was made just large enough and deep enough to hold a belt when it was loosely rolled. When a belt got too greasy, it was soaked for a time in gasoline. After the grease was cut, the belt was taken from the tank and scraped. When it was clean and dry, a coating of belt dressing was applied after which the belt was laid in a warm place to soak up the belt dressing.

After a time the management objected to the gasoline plan because of the expense and danger of fire. Then powdered chalk was used liberally. It was often sprinkled on the belts while they were running. Whenever a belt was out of service it was covered with powdered chalk and rolled up. This chalk absorbed much of the grease. After a belt had lain in chalk for a time it was scraped and dried. Then belt dressing was applied.

By a liberal use of chalk, scrapers and belt dressing the belts were kept in fair running conditions under very unfavorable conditions. C. V. HULL.

A Slide Rule Kink

ALTHOUGH the slide rule has been written about so much that one would think the subject completely exhausted, I have discovered a kink that is handy and I believe worthy of mention.

For example, when multiplying 7 by 155 on the lower or C and D scales, one cannot tell, without trial, which way to shove the slide—to the right or to the left. We pull it to the right, say, and after doing so discover that the 7 laps over beyond the end of the D scale, and our immediate impulse is to shove the slide the other way, and that is what we must do if our problem ends there. But if we are to divide the product of 155×7 by any other number, or multiply by any other number, we can set the hair line over the 7 even though it isn't on the D scale, and the answer will "come out right" anyway.

Pull out your slide rule and try this:

$$\frac{7 \times 155}{6} = 180.8$$

Try it several ways and try other problems with the hair line completely off the D scale and it will be found

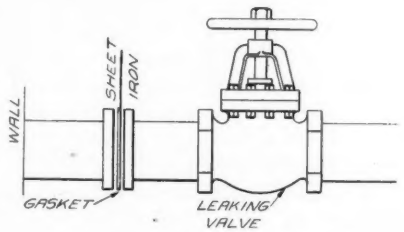
that this is a time saver, particularly as we sometimes set a slide with painstaking care only to find that our number is off the D scale, and then we do it all over again by shoving the slide to the other end. This scheme does away with the unnecessary shift in many cases.

With a real slide rule in your hand you will understand the idea quickly. It is a simple thing to explain with a slide rule, but not so easy to write about.

N. G. Near.

Replacing a Gasket in Hot Quarters

A hot job was recently left for me, and the illustration will show how we did it. A gasket in an 8-in. line had to be replaced and the valve leaked. This line is the header and located directly above boilers, therefore heat was intense. After cleaning faces of flanges using files ground at the end to the shape of wood chisels, we calipered flange face inside and out and cut the gasket, on account of leaking steam. I could not lay out bolt holes and rubber was so rotten that as soon as steam from valve struck it, the gasket would curl up like a corkscrew.



REPLACING A GASKET

I took a piece of sheet iron cut a hole in it so steam would pass this then fastened the gasket to it by simply punching 4 holes in iron first, then laid the gasket on the iron and fastened it by using tacks, turning the points over after forcing them through the gasket and sheet iron. Two C clamps were then used to bring flanges together to lay out holes. The sheet iron with gasket attached was slipped between flanges, iron toward valve, clamps were tightened holes laid out and cut, then bolts were started in all of them and gasket slipped off tacks, sheet iron withdrawn and flanges pulled up. The machinist helping me was about exhausted, so was I. This manner of putting in a gasket may not suit some people, but they were not there that night.

J. C. Lee.

Improvised Check Valve

Recently the check valve on a delivery line to a pressure tank developed some sand holes, or cracks, and started to leak quite badly. After examining it, I saw that it would be necessary to put in a new check. I looked among the pipe fittings in the store room to get one (it was a 2-in. check), but none was to be found. Our plant not being handy to a supply house, a new one was not obtainable in a hurry. I then went to look among the scrap to see if there might be anything that could be used. I found an old 2-in. globe valve which had a broken stem and stripped stuffing gland. I made this take the place of the bad check by a little alteration.

I removed the bonnet and took out the stem and disc. Next, I made a small disc of ⅛-in. sheet brass of just the exact inside diameter of the bonnet nut as shown in Fig. 2 at A. The stem was then made fast to the valve disc, and cut off to the proper measurements to give the required lift. After regrinding the valve disc

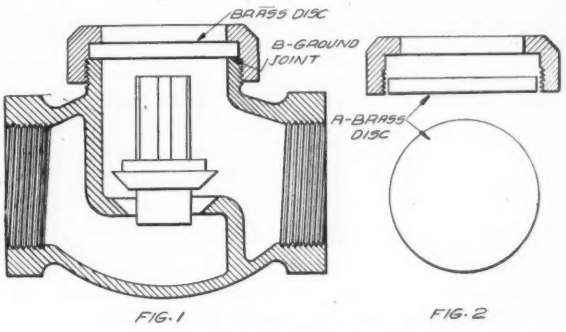


FIG. 1. CROSS-SECTION OF VALVE
FIG. 2. DETAIL OF DISC TO BLANK HOLE IN BONNET

and seat, and grinding the brass washer into the top of the valve at B, Fig. 1, it was then assembled, tested and found tight.

I then took out the old valve and put this improvised one in its place. No trouble has been experienced since it was installed.

C. H. W.

Thawing Water Pipes

Having occasion recently to thaw out a frozen water pipe in a location where it could not be reached with a torch, I hit upon a scheme which worked all right and had the line open in a few minutes. I tore a number of strips of heavy polishing cloth about 2 in. wide (the pipe to be thawed was ½ in.), and saturating them in lamp oil, laid them on the pipe where it was frozen. I then lit one end and allowed it to burn along the pipe, guarding the flame with a piece of tin so as not to set fire to some woodwork close above. This gave an even and uniform heat on the pipe and the water started to flow before the whole length of cloth was burned.

L. M. Johnson.

According to a newspaper report, when the big engine at the borough electric power house, Vineland, N. J., was stopped one morning there flopped from the flywheel what appeared to be a ball of oil waste, but it was alive, and the engineer finally identified it as the plant's pet cat.

Quoting further: "Kitty must have perched upon the wheel for a nap while the engine was idle temporarily the day before, and when it started up nobody noticed her. All day and night she clung to the wheel, which makes 150 revolutions a minute, and must have had some trouble in holding on." (Not so, for who in power plant circles has not lost his cap in a flywheel for a day's run?)

"The engineer estimated that pussy had traveled at least 500 miles in her giddy whirl."

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Coast Artillery Corps Examination Questions*

7. AN ENGINE that leaks at the piston rod packing pounds twice apparently at the crankpin on every complete stroke. What steps would you take to remedy this?

A. It is a difficult matter to state definitely just what causes the double pound at the crank center.

There is one thing that might cause this, and that is a short piston rod. If this strikes the front head, it will do so when the piston is at its slowest travel, and the contact will not be audible just there, but the effect will be heard both at the crankpin and the crosshead.

Assuming that this is the cause, when the piston is approaching the end of the stroke on the head end, the pressure behind it is naturally reduced almost to atmospheric, under ordinary conditions and to all intents and purposes, the reciprocating parts are being dragged along by the momentum of the flywheel, or at least the actual work being performed just at this point is very small.

Then when the piston strikes the head, the crankpin has not reached the end of the stroke and to do so and pass the center, an actual tension is placed on the rod, which tends to stretch it a small amount, possibly not over a few thousandths of an inch.

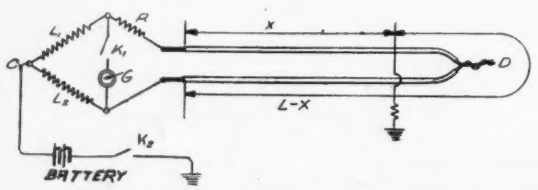


FIG. 3. DIAGRAM OF CONNECTIONS FOR TESTING FAULTY CABLE BY MEANS OF VARLEY LOOP

This, however, tends to bring the piston rod, crosshead and connecting rod, into a straight line, the same as if you drew a string with a washer or button on it, taut with your hands. The washer or button would naturally tend to rise, which is exactly what is done by the crosshead when it strikes the top guide violently, and as soon as the crankpin passes the center, the crosshead naturally resumes its position on the lower guide, either by force of gravity or the action of the steam in the cylinder on the return stroke, depending on whether the engine is rotating after the throttle is closed or working steam.

Some engine builders still cling to the old style rod that has the adjusting device for the pin brasses of such construction that any adjustment for wear shortens the rod, and continued wear and adjustment soon cause the piston to hit the head.

Remove the indicator connection and insert a piece of heavy fuse wire or strip solder, and roll the engine over the center, and you will soon see what clearance you have on the head end. Do the same on the other end, and divide up. Before you do so, however, look inside the cylinder and see if the ring has left a shoulder at the head end through not traveling over the counterbore.

Put the indicator on and see if you have a good steam distribution. You may have an abnormally high compression, and a late admission at the head end which would cause the double pound under certain conditions.

It could be in the main bearing, and especially so if there is but one take-up wedge, or it could be side play on the rod. Oil your hand and let it ride on top of the rod in its travel around several revolutions, and you may be able to locate something.

8. (a) What is the effect of zinc in a boiler to prevent corrosion?

(b) Why do some types of compound engines require receivers?

A. (a) The action of zinc used in a steam boiler to prevent the corrosive action of the water on the metal of the shell appears to be of an electrical nature, the zinc being one pole of the battery and the iron the other pole. The hydrogen goes to the iron shell and escapes as a gas into the steam; the oxygen goes to the zinc.

The actual value of zinc so used is quite questionable, some authorities upholding the fact while the experiences of many engineers point to the contrary. Much appears to depend upon the nature of the water used.

(b) Receivers are employed in connection with cross-compound engines to furnish a storage space for the steam between the high and low pressure cylinders. The necessity for a receiver is apparent when considering that the cranks of such an engine are at angles of 90 deg., with the result that at certain points of the stroke, more steam is exhausted by the high-pressure cylinder than required by the low-pressure cylinder and at other parts of the stroke the low-pressure cylinder must draw upon the receiver for steam, the high-pressure cylinder not exhausting a sufficient amount.

9. Is the carrying capacity of rubber-covered wire, as given by the National Electric Code, as large as that of weatherproof wire? If not, why not?

A. Allowable current carrying capacity of electrical conductors as given by the National Electric Code is less for conductors bearing rubber insulation than those having weatherproof insulation. This is due to the fact

*Continued from page 171, Feb. 1 issue.

that rubber insulation may be readily injured by comparatively low temperatures while other insulations will not.

10. Make a diagram and explain how to locate a ground on a cable conductor using the Varley loop and Megger.

A. In the ordinary Varley loop method in testing for a ground, the ratio between bridge resistance L_1 and L_2 remains fixed and a balance is obtained by means of a third resistance in series with the faulty cable as shown at R, Fig. 3. The resistance of loop L_1 formed by connecting the good and faulty cables in series, is first determined, and then resistance X to the fault may be computed by means of the equation of the Wheatstone bridge, after a balance is obtained:

$$\frac{L_1}{L_2} = \frac{R + X}{L - X}$$

which upon transposition will give us $X = \frac{L_1 L - L_2 R}{L_1 + L_2}$

Since all values of the quantities in the right-hand member of the above equation are known, the value of X may be determined and the distance to the fault calculated from the resistance per foot of the faulty wire.

When the Megger is employed this, which is a direct reading ohmmeter, is substituted for the Wheatstone bridge.

Water-Tube Boiler Specifications

WE ARE PLANNING the purchase of a new 225 to 250-hp. water-tube boiler good for a working pressure of 150 lb. gage, but before placing the order wish to advertise for bids.

Could you give us an outline for the specifications to be embodied in such an advertisement?

W. L. Y.

A. Due to the variety of designs of water-tube boilers on the market at the present time, specifications for such can at best be no more than a general statement of what is wanted. The best procedure is to give the following:

Number of boilers it is desired to purchase; amount of heating surface each is to have, which for a 250-hp. boiler, allowing 10 sq. ft. per hp., would be 2500 sq. ft.; amount of grate surface, which depends upon kind of coal to be used, the kind of draft, and the method of firing. In hand-fired plants using anthracite coal under forced draft, 40 to 50 sq. ft. of heating surface to 1 sq. ft. of grate surface has been found to give excellent results. Where bituminous coal is burned with natural draft, there is variation in the ratio of heating surface to grate surface ranging from 50 to 78, with an average of 60. For stokers employed with natural draft, conditions are much as with hand-fired furnaces, and good results are obtained with ratios of 50 to 60 to 1 of projected area.

In many plants boilers are installed with the intention to work them far beyond their rating at peak loads, and if natural draft prove insufficient for this forced draft with the ratio of 50 to 1 will allow the boiler to work at 300 per cent of its rating for short periods.

In addition to the location of plant for which boilers are wanted, and name of owner or owners of plant, such other information should be given as the kind of coal to be burned, the draft, kind of service required of boilers and chimney and flue dimensions. The bidders should be informed as to whether the furnaces are to be stoker or hand fired and should be asked to furnish detailed drawings showing all parts of the boiler and settings and a statement of the physical qualities of the metals used, the material of which the tubes are made, and the names of the manufacturers of the safety valves, blowoff cocks and water and steam gages. The character of the feed piping, whether iron or brass, should also be given by the bidders.

In general, the conditions under which the boiler is to be installed and operated and the service and performance of the boiler required should be given the bidders who in turn are to supply such information as will enable the purchaser to understand thoroughly just what each bidder proposes to furnish. O. H. H.

Comparative Coal and Oil Fuel Costs

WE HAVE an 80-hp. steam boiler under which we burn during the summer months an average of 75 tons of coal. Formerly this cost us $4.10 per ton, but of late we have been forced to pay $8 and $9, which we find too expensive. Assuming we installed a good oil-burning equipment, about how many gallons of oil would be required to take the place of the coal we now burn?

T. J. R. M.

A. The relative value of coal and oil as a boiler fuel depends, of course, on the price of the two kinds of fuel, as well as the heat value of each.

From recorded data, the heat value of Virginia residuum oil is about 19,200; West Virginia crude, 21,240; Pennsylvania crude, 20,736. As an average, with the special kind not known, it is usual to take 20,000 as the heat value for fuel oil.

For coal, the Beaver Pennsylvania has a heat value of 14,200; Virginia Coal River, 14,950; Kanawha, 15,150; West Virginia, 14,265. As a conservative value, it is safe to use 14,200 as the B.t.u. per pound of coal.

At $4.10 a ton, the cost of the coal is 0.205 cent per pound, so that the cost per 1000 heat units would be 0.0144 cent. With oil assumed at 5 cents a gallon, and a Baume test of 24 deg., which would give 7.57 lb. per gallon, the cost of the oil would be 0.66 cent per pound. This would make the cost per 1000 B.t.u., 0.033 cent, as compared to the 0.0144 cent per 1000 B.t.u. for the coal.

At the price of $8.00 per ton for the coal, the cost would be 0.028 cent per 1000 B.t.u., so that even at that price the coal is cheaper fuel. The price of 5 cents a gallon is about the current price for the better grades of crude at terminal points on the Atlantic Coast, and probably you will be able to get better prices than this in your locality; but the figures given will show you the method of determining the cost per 1000 B.t.u. for the fuels, which is the basis on which to compare them as bought.

Of course, the cost of producing steam from these fuels depends also on the efficiency of the furnaces used and the labor cost of handling these, which is less for the oil firing than for the coal firing, which includes the removal of ashes. A. L. R.

Some Massachusetts Examination Questions

KINDLY ANSWER the following questions, which were put up to me by Massachusetts inspectors.

1. If you wanted to run a noncondensing 4-valve engine condensing, what changes would you have to make?

2. Where would you look for fire cracks in a return tubular boiler? If you found a crack in the inside of the sheet extending from the rivet nearly to the edge of the plate, how would you repair it?

3. How would you level an engine shaft without removing it, if there is no room for a level? How would you square the center line of the main shaft with that of the crank shaft without removing it?

4. Why are the tube ends in a water-tube boiler flared instead of beaded as in the fire tube boiler?

5. How would you determine the pressure a flat stayed surface can withstand?

6. Suppose a stay or staybolt should let go in a boiler carrying a given pressure and you wanted to run the boiler, how would you calculate the safe working pressure? W. H. P.

ANSWERS

IN CHANGING an engine from noncondensing to condensing, no changes need be made if the valves were set right running noncondensing. It would, however, be well to have the cutoff come earlier, unless the load is increased when the condenser is started, otherwise the speed will be increased to some extent, depending upon the type of governor.

2. Fire cracks on a horizontal return tubular boiler are most liable to occur on the girth seam where exposed to the fire. One crack on the sheet extending from the rivet toward the edge of the plate is not particularly dangerous. Where there are a number of cracks, however, the cracked part of the plate should be cut out and replaced by a patch.

3. A water level should give good results in this case. Take a convenient length of rubber tubing and insert a short section of glass tubing at each end. With a tube end at each end of the shaft, pour a quantity of water in the tubing until a convenient level of water is obtained by which the comparative heights of the shaft ends may be determined.

A method which can sometimes be followed is to level the shaft as stated above, after which stretch a fine line on a level with the center line of the engine which can be found by the ordinary scale, center head, and level, and about 3 or 4 in. from the edge of the cylinder heads, letting the cord or line extend past the extreme travel of the crank, and also the head end of the cylinder.

Caliper the heads or other circular machined part which is available, noting the several diameters with great accuracy. Then, by means of tram sticks (or better still, an inside micrometer), measure from the cylinder heads or other witness point, to the string and set it so that you are satisfied that it is parallel with the imaginary center line of the engine and level with it as well.

Then place the crank on, say, the back center and tram from a given spot on the end of the crankpin over to the line. Turn the engine to the other center and tram again and if the measurement is the same, the shaft is in line with the engine. If there is a difference, move the outboard end of the shaft as required to secure the necessary accuracy.

Then with the engine still on the center tram over to the piston rod once at the gland and again at the crosshead, noting any difference in diameter that accurate measurement may develop, and making your calculations accordingly.

4. The ends of the tubes on a water-tube boiler are flared (and they are sometimes beaded also) to provide a secure joint with the header and prevent the header from being forced outward.

5. The pressure that a flat stayed surface will withstand may be determined from the following formula:

$$P = \frac{66\,(t+1)^2}{S^2 - 6}$$

in which P. = the working pressure, t = thickness of plate in 1/16ths of an inch, and S = maximum pitch.

6. With one stay or staybolt out of service, double the value of S and use the above formula to determine the safe working pressure. W. P.

Electro-Magnet Design

AN IRON RING has a sectional area of 100 square centimeters and a mean length of 300 centimeters. How many ampere turns are required to produce a total magnetic flux of 1,000,000 lines of force throughout the magnetic circuit? Assume u, or the permeability of the iron, to be 1000. C. F. G.

A. The relation between the magneto-motive force, M, and the flux, F, of any magnetic circuit is similar to Ohm's laws, namely, M = RF, where R is the reluctance of the magnetic circuit. This relation is also sometimes expressed as: F = PM, where P is equal to 1 divided by R, or the permeance of the magnetic circuit.

We find from a study of electromagnetics that in the C.G.S. (centimeter-gram-second) system the unit of magneto motive force is the gilbert, equal to 10 divided by 4π, or 0.7955 ampere turns. The magneto motive force, M, in gilberts, expressed as a function of ampere turns, is

$$M = \frac{4\pi}{10} \text{ I T} = 1.257 \text{ I T}$$

where I T represents the number of ampere turns; M is from the above, however, equal to F divided by P, so that we have

$$\text{F} \div \text{P} = 1.257 \text{ I T, or}$$
$$\text{F} = 1.257 \text{ I T P}$$

The reluctance of a uniform magnetic path such as this ring, is directly proportional to its length, l, and inversely proportional to its cross section, A, or

$$\text{P} = (\text{u A}) \div \text{L}$$

in which u is the permeability of the material of the magnetic circuit, in this instance, 1000.

Substituting the value of P in the last equation for F, we have

$$\text{F} = (1.257 \text{ I T u A}) \div \text{L}$$

Transposing this for I T and substituting the values given, the equation becomes

$$\text{I T} = \frac{\text{F L}}{1.257 \text{ u A}} = \frac{1{,}000{,}000 \times 300}{1.257 \times 1000 \times 100} =$$

2386 ampere turns. O. H. H.

Problems For Discussion By Readers

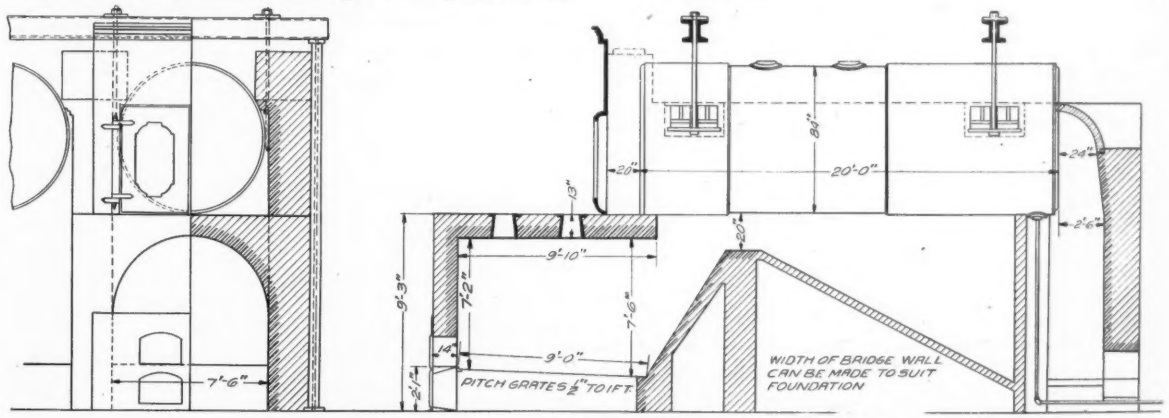
What Would You Do If You Had These Conditions To Meet?

What Setting Construction Would You Advise?

WILL SOME of our readers advance suggestions as to how E. A. Green may overcome the trouble he is experiencing?

He writes: "We have 3 84-in. by 20-ft. boilers set as illustrated in the accompanying sketch, but which do not give us satisfactory service. The grates, which we consider have too great an area, are each 7 ft. 6 in. by 9 ft.; the fuel is sawdust, shavings and hog feed from fir, hemlock and cedar. The boilers have each 118 4-in. flues and the stack is 7 ft. in diameter and 100 ft. high.

"I would be pleased to receive a sketch showing the proper construction of dutch oven setting for use with these boilers and the kind of fuel we burn."



THIS SETTING WHICH IS NOW USED IS FOUND UNSATIS FACTORY

How Much Oil Do You Use?

PROPER engine lubrication is a vital factor in the operation of all power plants. The use of an excessive quantity of oil in the cylinder of a steam engine is wasteful and ultimately adds materially to the cost per unit output; on the other hand, insufficient lubrication results in unnecessary wear of valves, valve seats, cylinders, pistons and piston rings and tends to shorten the life of the unit considerably. What, then, may we accept as the proper amount of cylinder oil which should be fed an engine if given dimensions and speed?

Little authentic data is available on this subject and as we frequently receive inquiries from operators as to the proper amount of cylinder oil an engine should be given, we are turning to those of our subscribers in charge of engines for information along this line.

Send us a list of the reciprocating engines in your plant with the number of cylinders of each, their dimensions, the number of revolutions per minute each engine makes and the quantity of oil fed each cylinder per hour or per run. If you give this in terms of the latter, be certain to appraise us of the number of hours which ordinarily constitute a run. In addition, we would like to know the grade of the oil used and whether this is mixed with graphite before being fed.

As soon as possible, the results of our findings will be made available to our readers, who, we are sure, will find such information of much value.

Won't you help us?

Measuring Boiler Plate; Blowoff Connection; Advancing Eccentric

IN ANSWER to the questions asked by L. B. on page 129, Jan. 15 issue of Practical Engineer, I believe he will have no trouble in getting the true thickness of his boiler plate at any lap joint, provided he removes all scale and makes sure that the plate has not been eaten away by the flames or by corrosion.

Should the blowoff pipe be found resting on the sleeve through the setting, the boiler should be put out of service and proper alterations made in the pipe to keep it in the clear. The extra strain put on the blowoff by being made to support a part of the boiler might be sufficient to cause a disastrous rupture, and to continue to operate a boiler with the blowoff in this condition would not be making safety first.

Advancing the eccentric on a Corliss engine will give an earlier admission. This does not necessarily mean that the valve is moving faster, but rather that it begins its motion sooner. J. M. Row.

FOR THE FIRST TIME in 50 yr. Great Britain has ordered a ship built in the United States. The Union Iron Works of San Francisco announces that it has closed a contract to build 3 10,000-ton steel freighters for British firms.—Chicago Commerce.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH
BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street,
CHICAGO, ILL.

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1917, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue, 22,000.

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Making the Most of the Visitor

Visitors to power plants may fairly be classified as either assets or liabilities, but it will not do to draw too sharp a line between technical and lay recipients of station hospitality. It ought to be the effort, however, of every man on the staff to do all in his power to bring out the latent ideas of visitors relative to the installation. In some plants where a large number of pass holders "hit the trail" annually from the coal yard gate to the cigar box in the chief's desk, a skeptical attitude of mind can be seen relative to the competency of such visitors to pass judgment or offer suggestions upon the work of the station organization; but let us not forget that even a man who cannot tell the difference between an oil switch and a frequency meter may now and then "uncork" an idea applicable to the mechanical side of the station which may contain the germ of a far-reaching improvement in operation. No, it will not do to assume an air of superiority, even when showing the clergy of the neighborhood the interesting points of the installation, for sometimes beneath the layman's untrained exterior an acute mind quick to grasp an opportunity for improvement lies in readiness.

Station work today is so comprehensive, so many trades are involved in plant construction, and so general is the interest of laymen in the handling of fuel, water and ashes by efficient equipment, in ventilation and welfare work, that good suggestions may often be received from unexpected sources. They need not be adopted unless worth while, but progress in applied science depends so much in this world upon small steps that it will not pay to overlook the possibilities of even the humblest visitor who is really in earnest.

The great difficulty is to obtain outspoken, free comment from station visitors, in numerous cases. Experts going through a station politely praise its evident good features, but tend to remain silent relative to the points in design or operation which seem to them open to criticism. Laymen are often apparently struck dumb by the unfamiliarity of their surroundings, yet the engineers on the job need the comments of both classes if they can be secured. Much depends on the attitude of the local staff. If critical comment and constructive suggestions are invited tactfully, great good may result. Out of common courtesy no one is going through a plant to pick flaws in it at every possible stage, but there is a vast difference between intelligent questioning and discussion and a silence that fails to reveal ideas upon vital engineering and administrative problems, ideas perhaps incomplete in themselves but often capable of valuable development. It is a good practice to find out the business of every visitor and to draw as close a parallel as possible in the trip through the station to the visitor's own specialty, giving the coal man, for instance, a special emphasis in relation to fuel handling, showing the mathematics teacher the ins and outs of log sheet plots, load curves, etc., and giving the doctor a special "look in" at the shower baths and lavatory facilities, emergency kit, and safety engineering points embodied in the plant. As for the engineering specialist, he will find his own line of interest in the representative modern plant, and if he gets away without benefiting the operating staff, so much the worse for the latter!

Saving Daylight

Several times in past years Practical Engineer has advocated rearranging our time system so as to take advantage of more of the daylight hours in our industrial work. During November and December there would be little effect either on our fuel expenditure for lighting or our living conditions, since preparation for the day's work, as well as its conclusion must be by artificial light. But for at least 9½ months of the year, not only could we gain more light for outdoor living by changing the relation between clock time and solar time, but a large saving in fuel resources could be effected by utilizing more of that free gift of Providence, sunlight. For a large part of the year, the peak load on lighting plants will be lessened and shortened giving greater service from a given installed capacity reduced cost and a better load factor.

The same effect would be secured if everybody would agree to change our schedule of working hours; i. e., start an hour earlier and quit an hour later, but that would require a universal, voluntary cooperation almost impossible to secure except after interminable argument and conference.

If, however, by government regulation, all clocks standardized by the government time signals were to be set forward 1 hr. at a stated time, the disturbance to business would be a minimum and for only once.

This is the plan recommended by the Daylight Saving Committee of the U. S. Chamber of Commerce, and seems the most feasible plan, with no objection except a change of the difference in time between the United States and other countries, and the amount of this difference is of little consequence except to astronomers.

On the other hand, the proposed change would give 4½ hr. of sunlight after 1 p. m. in December and 7½ hr. in June, or it would be daylight until 6 p. m. in December and 9 p. m. in June. The saving in expense for artificial lighting over the present time schedule can be easily realized without further figures, and the added daylight time for recreation will add much to the opportunity for healthful outdoor sports.

An alternative proposition of turning clocks ahead 1 hr. on Apr. 1 each year and back 1 hr. on Nov. 30 has an advantage only in the mental effort required to get up on winter mornings and would cause considerable confusion in industry and transportation twice each year at the times of changing. While it has been worked to a limited extent in European countries, the smaller areas involved makes the semi-yearly change less of a problem with them than it would be with us.

It is to be hoped that Congress will soon be convinced by the requests from the country at large that the plan is desirable and desired, and that the advantages of the increased useful daylight hours may soon be enjoyed by all of us.

Changing Shifts in the Power House

At the end of a long arduous shift in the power house, one engineer is ready to step out and let a new engineer take his place, and it is at just this trying period that the first man's true value becomes apparent. The condition in which he leaves the engine and boiler rooms stamps him as a shirk or as a capable man with a bigger and better job before him.

The shirk is the man who goes off watch leaving a foul engine, the oil and grease cups unattended to, etc., etc., or leaves the boiler room with thick, dirty fires on the grates, possibly the water level dangerously near the low limit mark, and gage-cocks leaking and the water glass obscured with dirt and grime and the ashpits full. The pumps may require packing and a thousand and one other details be neglected.

The capable man leaves everything as he would like to have it when he takes charge, so that a general inspection to see that all is well will be all that is required of the relief engineer on going on duty. There should be no "let George do it" in a power house; yet there is a good deal of shirking in many plants, particularly in the smaller ones which happen to be working under pressure. The salvation of the shirk, for there are many shirks who manage temporarily to hold on to their jobs, is the loyalty, painstaking effort and efficiency of his relief. No man enjoys taking over a neglected and untidy plant and it depends upon the pride he takes in his work and the appearance of his department how much of his predecessor's work he will do.

The shirk frequently seems to take keen delight in seeing how much he can "put over" the next man, but the time will come when the new man will refuse to be imposed upon further. The sooner this point is reached, the better, too, for all concerned. The lazy or irresponsible one nearly invariably has his shirking made possible through a mistaken sense of loyalty on the part of his victimized fellow worker and not until the latter realizes his true obligations to his employers and to himself will proper adjustment be made. No engineer should go on duty without first seeing that everything is in proper operating condition.

AN ARTICLE in a French engineering journal describes a case of vibration which occurred in Russia with a turbo-generator. It ran perfectly until the exciting current was switched on; then the whole building began to shake, and the machine had to be stopped. Careful examination showed that there was no defect in the machinery itself, and the vibration was then discovered to be due to resonance. The effect was caused by the box girders to which the machine was bolted; as soon as the front bolts were slightly loosened the vibration ceased. A permanent remedy was found in the employment of the Pearson type of coupling, wherein thin sheets of copper are inserted between the surfaces, which are bolted together.

HISTORY HAS IT that when coal was first in use a man was once tried, condemned and hanged for burning coal in London because of its "stink and smoke to the great detriment of health." That seems like a harsh measure for "smoke prevention," but proves that the agitation on the subject is not new. Such a ruling now would likely result in low smoke and high economy in a hurry.

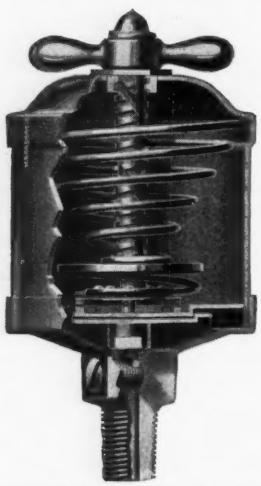
FOREIGN TRADE opportunities are available in Spain for the sale of greases for machinery and automobiles, No. 23,632; and for wrenches, electric and gasoline motors, No. 23,633. Full information can be had by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Emerson Automatic Grease Cup

MUCH of the prejudice against the use of grease as a machinery lubricant might be eliminated and frequently great savings effected if the proper type of grease cup would be employed. Many cups, however, are so constructed and have such characteristics as to be extremely wasteful, feeding an over-abundant amount of grease when not required or not feeding enough when most needed. As a consequence, due to the waste attending an over-supply, floors, walls and ceilings in close proximity to bearings so fed are badly bespattered and oil-soaked; while, with the cups feeding an insufficient supply, overheated and damaged bearings result.



SECTIONAL VIEW SHOWING INTERNAL CONSTRUCTION OF THE EMERSON GREASE CUP

Logically, then, it would appear as if the correct solution for this difficulty would be a cup which would eliminate waste, feed automatically with an even pressure any light, semi-fluid grease and produce maximum lubrication with minimum attention and care. These features it is said are to be found in the Emerson Automatic Grease Cup manufactured by the Buffalo Metal Goods Co., of Buffalo, N. Y. A sectional view of this cup is shown in the accompanying illustration.

Essentially the cup is composed of the body which contains a large main spring, a small feed spring, 2 toothed discs and a plunger. A slotted set screw inserted in the hexagonal nut at the bottom of the body serves to regulate the flow of the grease.

The main spring being compressed acts against the feed spring, compressing it about ⅛ in. This in turn engages the teeth on the upper side of the plunger and thereby prevents the rotation of the threaded stem. As a result, the action of the main spring is arrested and the feed spring only acts on the grease. When about ⅛ in. of the grease has been fed the teeth are released, the stem is revolved about ⅛ of a turn and the main spring is allowed to expand again another ⅛ in. or until the teeth again engage. The feed spring is now as before compressed, or set, to feed the grease and the cycle repeated.

As the function of the main spring is primarily that of compressing the feed spring it is only the pressure exerted by the latter which acts on the grease. And as the range of this from maximum to minimum is but ⅛ in., the pressure on the grease and consequently the feed is approximately uniform.

Liquid Rheostatic Control for A.C. Wound-Rotor Motors

THE extensive use of electric motor drive for mine haulages, hoists, dredges, and similar applications brought to the fore the necessity for a controller for large wound-rotor induction motors which would give wide and accurate speed variation, positive time limit acceleration, and allow the motor to run at reduced speeds for long periods. To meet these conditions, the Westinghouse Electric & Manufacturing Co. designed

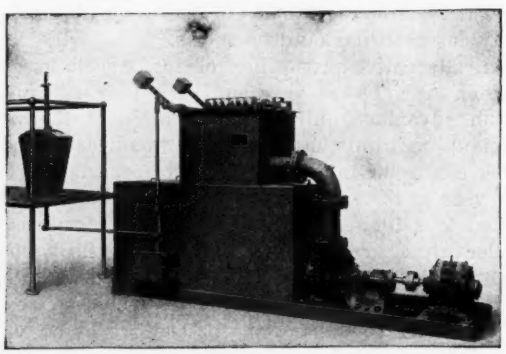


FIG. 1. GENERAL VIEW OF WESTINGHOUSE LIQUID RHEOSTAT

the liquid type of control shown in Figs. 1 and 2. These controllers have been in successful operation in various applications for the last 4 yr., and have proven equal to the most severe requirements.

A liquid controller consists essentially of a primary panel and a liquid rheostat. The primary panel is made up of mechanically interlocked magnetic contactors for starting, stopping, and reversing the motor, oil circuit breakers which entirely disconnect the motor from the

line in event of an overload, a fused knife switch for pump motor, and a low-voltage relay for the protection of operator and apparatus against voltage failure. The secondary control consists of a liquid rheostat complete with brass or wrought-iron cooling coils for varying the resistance in the motor secondary, a pump and pump motor switch for the circulation of the electrolyte, and a master switch for the control of the equipment. For plugging service, a single lever "H" slot device and 2 overload relays are used; these relays are mounted on the primary panel and protect the motor from overloads when running, but are short-circuited when plugging the motor. When operating under these conditions, the circuit breaker is set to protect the motor against exceptional overloads and short circuits on the motor, but too high to trip out in ordinary plugging service.

In the type of control shown, the depth of the liquid in which the electrodes are immersed is varied. This principle insures smooth acceleration and close speed regulation of the motor, as an infinite number of steps can be obtained by gradually varying the depth of the liquid, and eliminates objectionable jerks and sudden strains in both the cable and equipment when starting loads of large inertia.

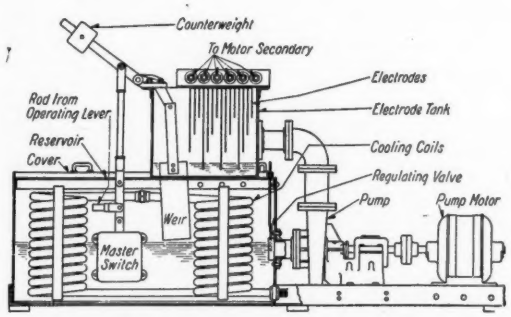


FIG. 2. DIAGRAM SHOWING GENERAL ARRANGEMENT AND INTERNAL CONSTRUCTION OF LIQUID RHEOSTAT

As shown by the diagram, Fig. 2, the 3 secondary phases of the motor are each connected to a set of electrodes suspended in the electrode tank. The operating lever is attached to an arm just above the master switch. When the lever is in the "off" position, the electrolyte, which is a solution of sodium carbonate (sal soda), is at its lowest level. When the operating lever is moved from the "off" position, the contactors in the primary circuit are operated by the master switch and the weir is raised. The electrolyte, which is circulated continuously by the pump, rises as the weir is raised. This immerses the electrodes more, decreases the resistance in the rotor circuit and speeds up the motor. By adjusting the position of the weir, the resistance in the rotor circuit is changed and the speed of the motor regulated.

A regulating valve in the pump discharge or intake pipe prevents the liquid from rising in the electrode tank at a rate greater than that for which the valve is adjusted; so the lever may be moved directly to the "full on" position while the liquid will rise at the rate determined by the valve setting. The weir, however, is of such a size and design that the electrolyte will flow through the lower compartment speedily enough to take care of plugging when that is practiced.

For plugging service, the single lever "H" slot device and the 2 overload relays afford a positive protection against the wrong operation of the lever. To prevent overtravel in hoist work, either single- or double-pole hatchway limit switches can be furnished. When the hoists are used for lowering, an overspeed device is desirable. Cam limit switches form another means of protection, safeguarding against accidents due to carelessness on the part of the operator. These consist of a number of switches operated by means of cams mounted on a hexagonal shaft connected to the driving motor or the driven mechanism through a chain and sprocket, or through a worm gear.

News Notes

R. GOODWYN RHETT, of Charleston, S. C., has been re-elected president of the Chamber of Commerce of the United States, following the Fifth Annual Meeting of that organization held in Washington recently. Other officers of the National Chamber have been re-elected as follows: Harry A. Wheeler, of Chicago; John H. Fahey, of Boston, and A. B. Farquhar, of York, Pa. Honorary vice-presidents: Samuel McRoberts, of New York City, vice-president; and Joseph H. Defrees, of Chicago, vice-president and also chairman of the Executive Committee. John Joy Edson, of Washington, has been re-elected treasurer. The newly elected officers are: Hon. Charles Nagel, of St. Louis, honorary vice-president, and Willis Booth, of Los Angeles, vice-president.

DR. W. F. M. GOSS, for many years associated with the Schools of Engineering, Purdue University, and since 1907, Dean of the College of Engineering of the University of Illinois, has resigned that office, effective March 1, 1917, to assume the presidency of the Railway Car Manufacturers' Association, an office to which he was elected on Feb. 1, subject to his release by the University authorities.

The Railway Car Manufacturers' Association is of recent origin. It is made up of representatives of 15 different organizations engaged in the manufacture of railway cars, freight and passenger. It will seek to establish co-operative relations with the purchasers of cars, and to aid especially in the matter of standardizing the design and specifications of cars. It will study problems of the industry as presented in the work of individual plants, such as cost accounting, welfare work, etc. The purpose of the Association, broadly stated, is to aid in increasing the efficiency of one of the country's great industries. It will work along broad lines on the theory that if the efficiency of the industry can be improved, benefits will accrue to the purchasers of cars and ultimately to all who use them.

AT A RECENT MEETING of Jenkins Bros., Farnham Yardley, son-in-law of the late Alfred B. Jenkins, and formerly vice-president, was elected president of the company to fill the vacancy caused by the death of Mr. Jenkins. Frank T. Swain, general manager, was elected vice-president. Samuel Laird, manager of the Philadelphia business, has been elected a director to fill the vacancy in the Board.

With these exceptions, the officers and directors are the same as heretofore.

The interests of Mr. Jenkins as a stockholder of the company will remain intact, under a trust created by his will, for the benefit of his descendants.

The policy of the company as laid down by Mr. Jenkins will be adhered to and maintained in all departments of the business.

BOUND BROOK OIL-LESS BEARING CO., Bound Brook, N. J., announces the election of its second vice-president, Spencer Weart, as president, and the election of its general manager, George Oakley Smalley, as treasurer.

C. C. CLELAND has been appointed sales manager of the Reliance Gauge Column Co., Cleveland, O., in place of F. Roberts, whose connection with this company has been severed.

THE SECOND Annual Drainage Conference of the University of Illinois is to be held March 13-15, 1917. Engineers, drainage officials, contractors, public officials, land owners and business men from all parts of the state will be in attendance to consider such important subjects as the reclamation of swamp and overflowed lands, flood control, and the conservation of the soil. The subject of land reclamation in Illinois is one of greater importance than is generally supposed. Although some 3,000,000 acres of uplands have been drained, there remain great overflowed areas of rich lowlands along the rivers, the aggregate extent of which is greater than that of Holland and the reclamation of which would add $150,000,000 to the land values of the state. The conference to be held at Urbana will have for its purpose the stimulation of greater interest in this problem. The speakers will be engineers and public officials of prominence and information regarding the practical phases of drainage will be made available to those in attendance. The organization and financing of drainage districts, the surveying of drainage areas, the design of systems, and improved methods of construction are among the subjects to be considered. The meeting will be in charge of the department of Civil Engineering, College of Engineering, Urbana, Ill.

ANNOUNCEMENT has just been made of the removal of the San Francisco office of the Westinghouse Electric & Mfg. Co. into a suite of offices in the First National Bank Bldg. of that city. These offices have been laid out with special reference to convenience and dispatch of details and conferences with customers. C. E. Heise is District Manager. The offices of the Westinghouse Lamp Co. are also included.

U. S. CIVIL SERVICE COMMISSION announces an examination, March 13, for mechanical draftsman. Vacancies occurring in the Panama Canal Service will be filled from this examination. The usual entrance salary for the position of first-class draftsman is about $150 a month, and for second-class draftsman about $125 a month. For the position of first-class draftsman the applicant must show (1) that he has graduated in engineering from a college or university of recognized standing and in addition has had at least 1 yr. experience as actual draftsman; or (2) that he has had at least 3 yr. experience as actual draftsman and in addition 6 mo. of machine or forge shop work or on mechanical construction. For the position of second-class draftsman the applicant must show (1) that he has graduated in engineering from a college or university of recognized standing; or (2) that he has had at least 2 yr. experience as actual draftsman; or, (3) that he has had at least 1 yr. experience as actual draftsman and 1 yr. in the machine or forge shop or on mechanical construction. Eligibles in the first class or eligible to second class positions may be given preference in making appointments thereto, provided they state in their applications their willingness to accept appointment to the lower position. Applicants must have reached their twentieth but not their forty-fifth birthday. The mechanical draftsman examination for the Panama Canal service scheduled in the Manual of Examinations for the spring of 1917 to be held on April 11, 1917, is hereby canceled. Apply for Form 2118.

Book Reviews

ELEMENTARY CAMS, by F. DeR. Furman; cloth; 90 pages, 69 illustrations; 5¾ by 9 in.; New York, 1916. Price, $1.25.

Cams, considered on a scientific basis, have been more neglected in engineering literature than any other of the important branches of mechanism, as is shown in his preface, by the author who contrasts the lack of technical analysis in cam design with the highly developed subject of toothed gearing.

With the increasing introduction of automatic machinery, the size and form of the cams employed calls for a comprehensive method of technical analysis. This book has been prepared, therefore, to assemble in permanent form, information concerning the various types of elementary cams in common use. Most of the base curves employed in cam designing are described and their applications explained.

Dividing the book into 5 sections, these chapter titles are given: Definitions and Classifications; Method of Construction of Base Curves in Common Use; Cam Problem and Exercise Problems; Timing and Interference of Cams; Cams for Reproducing Given Curves or Figures.

The work is entirely graphical and does not require a knowledge of mathematics, but does presuppose on the part of the reader, proficiency in drafting and the design of machine details. For those called upon to design cams, it will be found a valuable assistant.

ENGINEERING OF POWER PLANTS, by R. H. Fernald and G. A. Orrok; first edition, 586 pages, 309 illustrations; New York, 1916. Price, $4.

Besides offering much general material relating to the engineering of power plants, the two underlying thoughts in the preparation of this text (according to the authors and as may be readily appreciated from a study of the book) have been—(a) To bring the student to realize that engineering, although based on the exact sciences, is not itself an exact science, but requires on the part of the successful engineer a natural fund of "common sense" and the application of engineering judgment; and (b) To give the student some idea of the commercial side of engineering.

It is these two highly important features which distinguish the book from the ordinary text on the subject

and which should make it prove of value not only to the technical school student but also to the man in the field; and while the cost figures presented must of necessity be used with caution, due to market variations and local conditions, they will at least serve in forming general estimates.

All phases of steam engineering, including such subjects of economics as operating cost, variable load economy and cost of power, internal combustion engines, producer gas and gas producers, compressed air, and hydraulic power are considered.

Numerous problems are presented at the end of each chapter which, if solved, will aid the student toward a more thorough understanding of the subject.

ELEMENTARY MATHEMATICS FOR ENGINEERS, by Ernest H. Sprague; 4 by 7 in., 230 pp., with diagrams and tables; London, 1916. Cloth, $1.50.

Short discussion is given of some short-cut arithmetical methods, then algebra, plane and spherical trigonometry, geometry and calculus are treated in order. The author presupposes a considerable acquaintance with mathematical processes, and briefly reviews the fundamental ideas, then going on to explain the use of the various methods, the few actual examples given being largely taken from civil engineering. While not extremely difficult, the treatment of the various branches of mathematics is not simple, and the book is to be recommended only to those who have had the equivalent of a full high school course in the fundamentals of algebra, geometry and trigonometry.

THE MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1917; 388 pages; illustrated; Manchester, Eng., 1917. Price, $0.35.

In this, the thirtieth annual issue, new tables have been introduced giving dimensions of Piston Rings, Governors, etc., and notes on Lubrication and Antifriction Bearings are now included. The section on Steam and the Steam Engine has been largely rewritten.

Because of the rapidly growing importance of the subject, a new section has been introduced on The Heat Treatment of Steel, including notes on Annealing, Hardening, Tempering, etc. Tables giving the dimensions of Flanged Couplings, and for the calculation of Springs have also been inserted. The book covers power plant apparatus, machine shop practice and transmission equipment and contains the mathematical tables most frequently used in engineering practice as well as space for daily memoranda and records for the year.

Catalog Notes

OHIO BRASS gate valves are illustrated in a folder just received from The Ohio Brass Co., Mansfield, O.

LIST OF PUBLICATIONS of Allis-Chalmers Manufacturing Co., Milwaukee, Wis., a booklet listing all the company's publications now in force, was recently published.

THE SHONE SYSTEM of pneumatic ejectors for automatically raising sewage and drainage from basements below street sewer level, municipal sewerage systems, etc., is illustrated in cross section, plan and elevation in Bulletin No. P-4000; manufacturer, Shone Co.; general sales agents, Yeomans Bros. Co., 231 Institute Pl., Chicago.

REDUCING FUEL COSTS at the Schenectady plant of the General Electric Co. is the title of a circular relating to equipment of that company's boilers with Diamond Power Specialty Co.'s Diamond Soot Blowers.

EMERSON steam vacuum pumps, Emerson foot valves and quick cleaning strainers manufactured by The Emerson Pump and Valve Co., Alexandria, Va., are described and illustrated in the company's 1917 catalog.

LADD WATER-TUBE BOILER is the subject of Catalog No. 17, discussing the several types, details of construction and operation, efficiency and upkeep of this boiler, which is manufactured by The George T. Ladd Co., Pittsburgh, Pa.

COCHRANE HEATERS for steam power plants, as used in heating, metering and softening water for boiler feed and other purposes, are illustrated and described in a new 106-page catalog, No. 710, from Harrison Safety Boiler Works, of Philadelphia.

HOW TO MEASURE SCREW THREADS is the title of Bulletin No. 1 issued by Greenfield Tap & Die Corp., Greenfield, Mass. It is the first of a series of bulletins upon this subject, and will be found of interest and value to all who have to make threads upon bolts, piping, etc. Copies may be had by writing the company at the above address.

"THE SILK-THROWING INDUSTRY in Northeastern Pennsylvania," by G. F. Smith and Elmer L. Kyle, a reprint of an article which appeared in the Electric Journal, September, 1915, has just been issued in pamphlet form by the Westinghouse Elec. & Mfg. Co. This paper describes the textile industry in Northeastern Pennsylvania, and describes the operations performed by the machines used.

Trade Notes

THE OHIO STEAM SPECIALTY CO., Cleveland, Ohio (F. Roberts, president), will soon place upon the market the "OSSCO" Safety Water Column, and other specialties. Mr. Roberts recently resigned the managership of The Reliance Gauge Column Co., which he held for 9 yr.

AN INTERESTING CHANGEOVER from mechanical to electric drive has recently been made by the thread mills in Spray and Draper, N. C., controlled by the Marshall Fields interests, involving the installation of approximately 6000 hp. in Westinghouse induction motors. This is probably the largest changeover that has ever been made by any one set of textile mills at one time.

Power for the operation of the motors is transmitted from the station of the Southern Power Co., Greensboro, N. C., at 44,000 v. It is stepped down to 13,200 v. at Spray and further stepped down by outdoor substations at the different mills to 575 v. for use.

Westinghouse 550-v., 3-phase, 60-cycle induction motors are used exclusively, on small group drives. Four-frame and 2-frame drive is employed for the spinning frames, the motors being of the double extended shaft type with 2 pulleys on each end.

ALLEN & GARCIA CO., consulting and constructing engineers, McCormick Building, Chicago, announce the establishment of a Power Department, which will be in charge of C. M. Garland, who is widely known as an expert in the different phases of steam gas power engineering. The electrical work in connection with this department will be handled, as at present, by W. C. Adams.

WARREN WEBSTER & CO., Camden, N. J., announces that the Power Equipment Co., 131 State St., Boston, Mass., has been selected to represent its feed water heater department in the New England territory, co-operating with the company's established branch office in Boston. V. F. Holmes and his associates in the Power Equipment Co. have special training and facilities for taking care of this branch of the business. This department will be in charge of John Jay, who has been transferred from Camden to Boston.

THE MAGNOLIA METAL CO. has purchased property in San Francisco and will commence at once the erection of a factory for manufacturing Magnolia Metal and other babbits and white metal alloys. Equipment for this plant has already been shipped and it is expected that it will be in operation within the next few weeks. This action was necessitated by the growth of the company's trade on the Pacific Coast, and this will make the fifth factory, as the company is at present operating plants at New York, Chicago, Matawan, N. J., and Montreal, Canada.

ANNOUNCEMENT has been made of the establishment of the firm of L. S. Shaw & Co., with offices in the Dime Bank Bldg., Detroit, Mich. The company will deal in power plant equipment, specializing in high-grade apparatus.

Mr. Shaw has had fifteen years' experience in power plant design, construction and equipment, having been with the Consolidated Gas Co. of New York, J. G. White & Co. and the Edison Co. of New York. For the past 5 yr., he has been manager of the power department of the Westinghouse Companies at Indianapolis, Chicago and Detroit.

THE COMBUSTION Engineering Corporation, 11 Broadway, New York City, announces the doubling of the size of its New York offices, to accommodate the increase in business due to the constantly increasing demand for its Type "E" Stoker for bituminous coal, and the Coxe Stoker for anthracite coal.

It further announces the organization of six additional erecting units, each under the direction of a superintendent for field work, and the establishment of a service department under the direction of John Morris who has been associated with the company since its organization. Mr. Morris will have under his direction a corps of competent engineers who will keep in constant touch with the trade with the idea of rendering the customers of the Combustion Engineering Corporation free inspection and engineering service at all times.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

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Stippled plates used, but no heavy, black and white plates.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

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All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, a.c. and d.c. machines; strictly sober; 34 years old, married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 455, Practical Engineer, 537 S. Dearborn St., Chicago. 2-1-1

POSITION WANTED—By engineer 30 years old, married; 7 years' experience with Corliss and high speed engines, refrigeration and d.c. generators. Address Lee McCallum, 512 N. Park, Cadillac, Mich. 1-15-2

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, a.c. and d.c. machines, strictly sober. 34 years old, married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 455, Practical Engineer, 537 S. Dearborn St., Chicago. 1-15-2

POSITION WANTED—As chief engineer in industrial plant, Missouri, Arkansas, Kansas, Iowa or Nebraska, or as Superintendent of light and water plant in city of 2500 to 8000. Ten years' practical experience with steam, electrical and water systems. Technical training. Now employed by U. S. Government as engineer and instructor. Executive ability. Can report on 15 to 30 days' notice. Married. Age 30. Address Practical Engineer, Box 466, 537 S. Dearborn St., Chicago, Ill. 2-1-1

POSITION WANTED—As engineer in small plant or assistant in large power plant. Have had 5 years' experience as engineer in grain elevator. Am good mechanic, sober and steady habits; 28 years old. Central States preferred. Fair salary to start. Address Box 115, Walcott, Ia. 2-15-2

POSITION WANTED—By man, 30 years old, good habits, married, with 6 years experience in steam electric plants. Would like position as engineer in plant of 2500 k.w. capacity or more, where I can advance myself. Address Box 471, Practical Engineer, 537 S. Dearborn St., Chicago, Illinois. 3-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—A first-class fireman to look after twelve 150-hp. tubular boilers; one who is well up in economy in coal and understands thoroughly the care of boilers; must be sober, industrious and steady. A good position for the right man. Address Practical Engineer, Box 469, 537 S. Dearborn St., Chicago, Ill. 2-15-3

WANTED—A Refrigeration Engineer in Western Pennsylvania. Must be familiar with raw water ice making systems and electrical machinery. State salary wanted. Address Box 472, Practical Engineer, 537 S. Dearborn St., Chicago, Illinois. 3-1-1

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

FOUR COPIES of Practical Engineer for February, 1910, in good condition; we will extend your subscription for three months. Circulatiou Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

MARINE BOILERS WANTED—From 50 to 250 horsepower. We will pay cash awards for information that leads to a purchase. The Pittsburgh Boiler & Machine Co., Pittsburgh, Kans. 1-1-6

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Illinois. tf.

For Sale

FOR SALE—Buckeye 120-hp. hor. single act. Tandem Gas Engine; two 28-hp. 4-cyl. Clifton Marine Engines; one 15-hp. Foos Gas Engine; 8-16 Springfield 12-hp. stationary Gas Engine. Int. Equipment Co., 517 Monadnock Bldg., Chicago. 3-1-2

FLOUR MILL FOR SALE—At a sacrifice, a 25-bbl. Nu-Way Short System Flouring Mill, complete with electric drive; 10-in. Letz Feed Mill; 20-in. stone Buhr Corn Mill, good operating condition, practically new. A real bargain if taken at once. No other mill within 20 miles. Address Box 282, Edina, Mo. 3-1-1

FOR SALE—McKenzie grain grate stoker, practically new. Address A. P., 517 Monadnock Bldg., Chicago, Ill. 3-1-2

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C.

PATENTS — Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washingon, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

"The Advertisements Are Rich with Information"

So says the chief engineer of a large power plant in New England (name on request). The following is an extract from a letter recently received by the Editor of the Sparks page. Read it:

"I have always read with real interest the Sparks from the advertising pages. There have always been a couple of pointers in them for me, and I've enjoyed the interesting manner in which that page has been edited. There is a paragraph on that page of the Feb. 1st issue, which reads:

"If you have read and studied engineering literature, both editorial and advertising—if you have posted yourself on power plant equipment—if you know what the engineering market has to offer the buyer of power plant equipment—if you know your plant, its needs and opportunities for development, you need not worry about reaching the last lap unsuccessful."

That paragraph contains three "ifs" which are mighty important factors to the power plant engineer, even though he does not do the actual buying. . . . Nearly every ad is rich with information, and comes in a different manner in various copies throughout the year.

I have adopted a plan to reap a benefit from these, which I believe would interest others. I have always separated the advertising pages from the editorial pages of each issue of PRACTICAL ENGINEER. . . . I look through all the ads to see if there are any new equipment, or points about the standard engineering products. Should I find any—and I nearly always do—I clip the ad. and file it away in my collection.

I have a small wooden box, 9½ x 12 x 15 in., nicely painted, and in this, under various nomenclature headings, I file the ads, using stiff pieces of brown wrapping paper on which to paste the less than full page ads. Many different interesting articles are filed here in series of ads that are ever changing in the manner in which they are written.

I am in a position to know what is offered to improve any condition in the plant, and when any opening is shown, I immediately get into conference with the superintendent, and can discuss the merits of all the different equipment offered on the market. When I send for any literature spoken of in an ad, I make notes on it to show that I have done so.

Many otherwise idle moments are profitably used up in the evenings at home in keeping this file. I really have gotten to like the work of keeping it up to date. This, along with my engineering library, is one of the chief reasons that I never worry about reaching the "last lap unsuccessful."